Of computers myths and modelling

The social construction of diversity, knowledge information and communication technologies in Dutch horticulture and agricultural extension

Cees Leeuwis

Stellingen

1. Het gebruik van management ondersteunende computer programma's impliceert een intermenselijk communicatieproces. Daar de betekenis van hetgeen gecommuniceerd wordt niet vaststaat (maar onderhevig is aan 'onderhandeling') is de term 'informatietechnologie' misleidend, en is het inzichtelijker om te spreken over communicatietechnologie. (dit proefschrift)

2. De gangbare opvattingen over begrippen als data, informatie en kennis in de informatica (onder andere inhoudende dat het bij data zou gaan om feiten die dienen als input voor een computerprogramma, dat deze data met behulp van de in het computerprogramma opgeslagen kennis zouden worden geïnterpreteerd, en aldus worden omgezet in informatie) weerspiegelen een objectivistische ontologische stellingname en een 'mechanische' conceptualisering van communicatie. Voor het begrijpen van het gebruik van computerprogramma's is het zinnig om geen scherp onderscheid te maken tussen data, informatie en kennis, en in plaats hiervan te spreken van kennisconstructen met een verschillende mate van concreetheid en complexiteit. (dit proefschrift)

3. Repertoires van gedeelde kennis en gedeelde onwetendheid kunnen worden gezien als de fundamentele modaliteit van structuur. Dergelijke repertoires liggen daarom ten grondslag aan machtsuitoefening en aan het bestaan van structurele kenmerken in de maatschappij. (dit proefschrift)

4. Zelf-referentie is inherent aan planmatige benaderingen van ontwikkeling. In verband hiermee lenen programma- en/of projectevaluaties zich bij uitstek voor het construeren van gebieden van onwetendheid. (dit proefschrift)

5. De definitie en de structurering van 'een probleem' zijn nooit neutraal. Het is daarom misleidend een scherp onderscheid te maken tussen ongestructureerde en gestructureerde problemen. (dit proefschrift)

6. De meest waardevolle communicatietechnologieën zijn die welke kunnen dienen als hulpmiddel om te leren. (dit proefschrift)

7. Hoewel door velen wordt onderkend dat het ontwikkelen van een communicatietechnologie een leerproces impliceert, zijn slechts weinig methoden van communicatietechnologie ontwikkeling erop ingericht snel recht te doen aan leerervaringen. (dit proefschrift)

8. Naarmate de complexiteit van het intern ontwerp van een communicatietechnologie toeneemt, wordt de mate waarin een communicatietechnologie anticipeert op diversiteit meer afhankelijk van een adequaat extern ontwerp. Hetzelfde geldt voor de mate waarin met behulp van een communicatietechnologie een integratie van kennis die afkomstig is van verschillende epistemische gemeenschappen tot stand kan worden gebracht. (dit proefschrift)

9. Een indeling in termen van bedrijfsstijlen verschaft niet in elke interventie-context het scherpst mogelijke inzicht in de relevante diversiteit. (dit proefschrift)

10. Het managen van een boerenbedrijf is aanmerkelijk veel gecompliceerder dan het spelen van een partij schaak; niet in de laatste plaats omdat over de 'spelregels' voor de bedrijfsvoering voortdurend onderhandeld wordt. Het is daarom een fictie te denken dat men de bedrijfsvoering van agrarische bedrijven op valide wijze kan simuleren.

11. Shakespeare's toneelstukken benaderen de werkelijkheid omdat, net als in de werkelijkheid, elk afzonderlijk woord, iedere zin, ieder personage, en elke gebeurtenis een onbeperkt aantal interpretaties kent (Peter Brook, 1987:76). Alleen al daarom is het onzin om -zoals Begley et al. (1980) doen- te beweren dat een computerprogramma in staat zou zijn om een Shakespeariaans plot te begrijpen. (Peter Brook, 1987, *The shifting point: Forty years of theatrical exploration 1946-1987.* Methuen Drama. London. / Sharon Begley, John Carey & Michael Reese, 1980, How smart can computers get?, In: *Newsweek,* Vol. 95, No. 26 (June 30), pp. 52-53.)

12. Zij die allochtonen oproepen tot meer inspanning om in de Nederlandse samenleving te integreren zien niet zelden over het hoofd dat: (a) allochtonen wellicht geïntegreerd zijn in autochtone subculturen waarin zijzelf niet zijn geïntegreerd; (b) integratie een tweezijdig proces is; en (c) het oprichten van allochtone scholen, sportverenigingen en andere organisaties ook gezien kan worden als een uiting van integratie in een multi-culturele maatschappij als de Nederlandse.

13. Het verschijnsel dat ontwikkelingssamenwerkingsprojecten door Nederlanders worden getoetst op hun mogelijke consequenties voor (onder andere) de positie van vrouwen, de kwaliteit van het milieu, en de positie van 'de armsten der armen', laat zien dat het Nederlandse ontwikkelingssamenwerkingsbeleid nog immer doordesemd is met paternalisme en missiedrang.

14. Met zijn visuele vermogens en kennis van lokale omstandigheden en mensen, levert het personeel van vuurtoren de Brandaris (Terschelling) een onvervangbare bijdrage aan de veiligheid op de Waddenzee. Verdergaande automatisering van de vuurtoren, resulterend in het ontslag van personeelsleden, is daarom ongewenst.

15. Het rijden van een Elfstedentocht is een zaak van lange adem. Dit maakt hem bij uitstek geschikt voor personen die kortademig zijn, omdat juist zij geleerd hebben hun adem te sparen.

Stellingen behorende bij het proefschrift: Of computers, myths and modelling; The social construction of diversity, knowledge, information, and communication technologies in Dutch horticulture and agricultural extension. Cees Leeuwis. Wageningen, 17 december 1993.

Of computers, myths and modelling

The social construction of diversity, knowledge, information, and communication technologies in Dutch horticulture and agricultural extension.

Promotoren:

dr. Niels G. Röling, voormalig hoogleraar in de voorlichtingskunde

dr. Norman Long, hoogleraar in de rurale ontwikkelingssociologie

Cees Leeuwis

Of computers, myths and modelling

The social construction of diversity, knowledge, information, and communication technologies in Dutch horticulture and agricultural extension.

Proefschrift
ter verkrijging van de graad van doctor
in de landbouw- en milieuwetenschappen
op gezag van de rector magnificus,
dr. C.M. Karssen
in het openbaar te verdedigen
op vrijdag 17 december 1993
des namiddags te half twee in de Aula
van de Landbouwuniversiteit te Wageningen.

CIP-DATA KONINKLIJKE BIBLIOTHEEK, DEN HAAG

Leeuwis, Cees

Of computers, myths and modelling : the social construction of diversity, knowledge, information, and communication technologies in Dutch horticulture and agricultural extension / Cees Leeuwis. - [S.l. : s.n.]. - Ill.
Also publ.: Wageningen : Landbouwuniversiteit Wageningen, 1993. - (Wageningen studies in sociology, ISSN 0923-4365 ; 36). - Thesis Wageningen. - With ref. - With summary in Dutch.
ISBN 90-5485-197-X
Subject headings: rural sociology / information technology

This thesis is also published as number 36 in the series of Wageningen Studies in Sociology

Photograph and design cover: Luc Dinnissen

Printed in the Netherlands by Grafisch bedrijf Ponsen & Looijen b.v

Contents

Part II: EMPIRICAL INVESTIGATIONS

Acknowledgements

Thesis-writing is often portrayed as a lonely activity. It is, and it is not. While writing, one cannot avoid at times to more or less withdraw from social life, and to spend many hours with only books and a computer to socialize with. At the same time, one has to rely on many people while working, and even when physically alone one tends to be in continuous imaginary debate with others. Moreover, the research itself, draft chapters and articles, bring one into contact with a great variety of people. At this point, I will seize the opportunity to express my gratitude to a number of these people.

First of all, I wish to thank my promoter, Niels Röling, who with his confidence, never failing enthusiasm, always changing ideas, and readiness to accept criticism, has been a major stimulant and source of inspiration to me. I have been equally inspired by my second promoter, Norman Long. I am particularly thankful that Norman gave me the opportunity to share in the debating culture that exists among the group of young academics that has emerged in the slipstream of his intellectual activities.

In many ways, my godfather in sociology has been Jan Douwe van der Ploeg; if it wasn't for him I would probably not have ended up in this field of study in the first place. At a difficult moment in the research process, Jan Douwe offered me the opportunity to cooperate with him and my university friend, Dirk Roep, in conducting a case-study. I am grateful to both of them.

I also wish to express my gratitude to all members of the Department of Communication and Innovation Studies at Wageningen Agricultural University for providing such a pleasant environment in which to undertake research, for contributing resources, and for letting me become part of their community. I wish to especially thank the administrative staff without whom the atmosphere in the Department undoubtedly would be far less enjoyable. Similarly, I am particularly grateful to Paul Engel and Hedwig te Molder with whom I have cooperated on several occasions and who have also been influential in shaping my ideas. I am deeply indebted to Marlèn Arkesteyn who was my research assistant for nine months, and who conducted numerous valuable in-depth interviews.

I am grateful for the fact that I can, notwithstanding my membership of a different Department, still consider the members of both the Department of Rural Sociology and the Department of Sociology of Rural Development to be my colleagues as well. Of the latter Department, I wish to express my special gratitude to Jan Kees van Donge, whose critical outlook, warm concern and encouragement I have appreciated very much. I also wish to thank the students in sociology who have been involved in conducting interviews in behalf of one of the case-studies.

In the editorial board of *Agro Informatica*, I have found yet another group of fine colleagues, who have contributed greatly to widening my view in the domain of agro-informatics.

I am very much obliged to all persons who have been willing to act as respondents and/or give access to important case-study material. In relation to my first case-study, I would especially like to mention the dairy farmers and extension workers in De Achterhoek, and staff of CR-Arnhem, DLV and IKC-Animal Farming. Similarly, in connection with the second and third case-study, I would like to express my gratitude to the cucumber growers and their study clubs in Drenthe and Brabant/Limburg, to the horticultural extension workers in these regions, to the fruit-vegetable growers and their study clubs in the Westland and De Kring regions, and to staff of DACOM, SITU, NTS and the vegetable auctions. I thank DLO for having provided additional funds that made it possible to do some of the fieldwork.

In addition to Niels Röling and Norman Long, several persons have wrestled their way through (parts of) the manuscript, and have given valuable comments. To my pleasant surprise, one of them was Bruno Benvenuti who made me think seriously about humbug and charlatanry. I am eternally indebted to my cousin Jacqueline Leeuwis, who has taken on the tremendous task of taking a fine-tooth comb through my English. I admire her commitment, precision and enthusiasm. I also thank Frank Vanclay, who, at the last minute, provided valuable editorial comments, and helped me to overcome once more my aversion for statistical analyses.

I am thankful for -and impressed by- Luc Dinnissen's dedication in designing a beautiful cover for this book.

Although perhaps a paradox, the theatre company 'Stichting Lens' has contributed greatly to keeping me in touch with the 'real world'. I wish to thank all actors, staff members and other persons involved with 'Lens' for being a great bunch of people. Without the ever-continuing commitment and passion of Stone van den Hurk, Petra Wilmer and Bart van den Hurk, our theatre company would not be nearly as flourishing. I am thankful to them in particular.

I thank my family for their love and support. I very much enjoyed the many simple meals my father cooked at very short notice, and I greatly appreciate my mother's extrovert warmth and interest (even if I cannot always show that). I am grateful to my sister for being my younger sister, and to my older brother who -in the end- is always supportive.

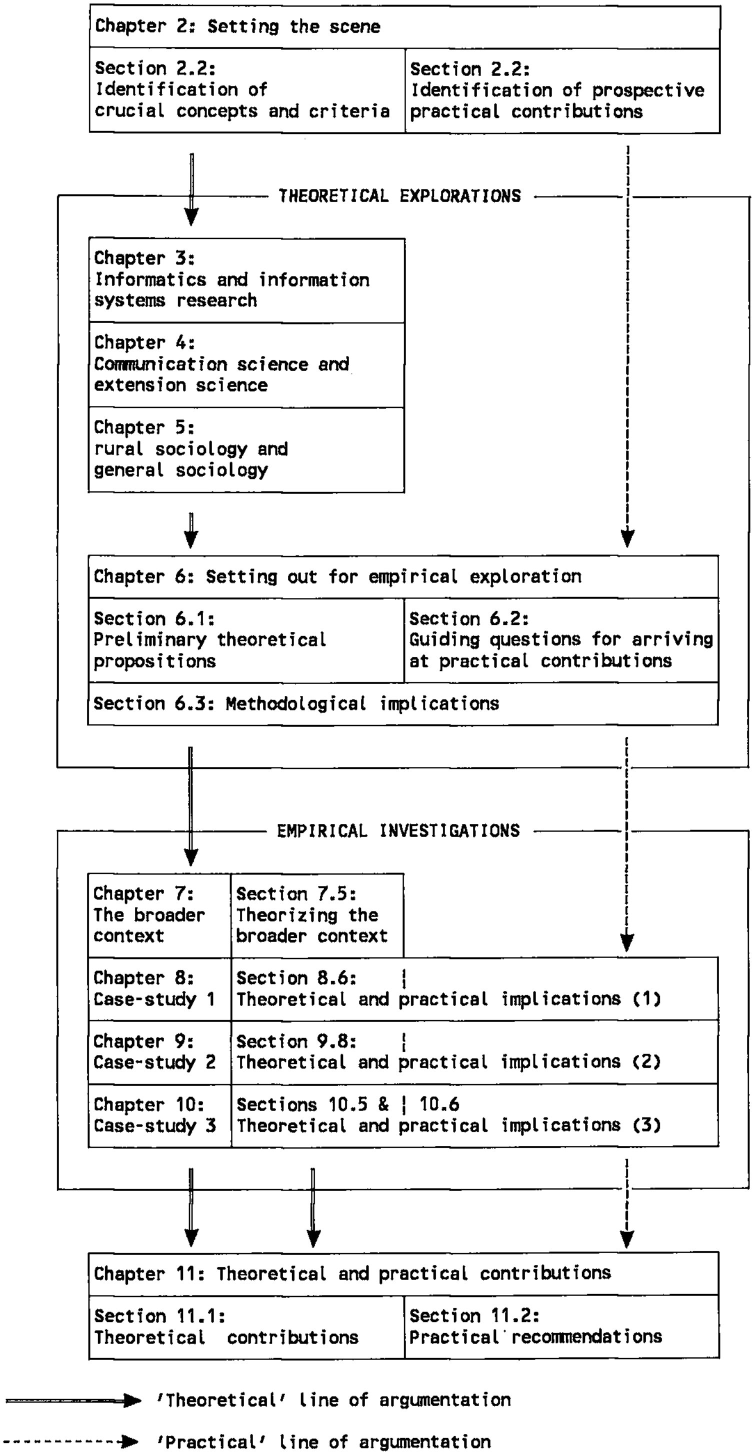
I am obliged to my house-mates, Connie Ettema and Titus Visser. They have probably seen the worst of me at times, and have put up with my capriciousness.

Finally, in addition to a certain degree of academic development, there may have been some personal growth as well. If there was any, I must thank my friends and loved ones for -wittingly or unwittingly- giving me valuable lessons in life. In this respect, I am grateful to Nettie Aarnink, Marlèn Arkesteyn, Houkje Berger, Anita Blijdorp, Mariëtte Claringbould, tax-payer René (Knuf) van Corven, Thea Hilhorst, Mariël Mensink, Mara Miele, Suzy Muwanga, Bert Palsma, Jan Pijnenborg, and Willem and Janny Venneman. For a range of things, I want to thank Noëlle Aarts; not least for her passionate way of life, and for teaching me how to really dance.

Now my charms are all o'erthrown,
And what strength I have's mine own;
Which is most faint: now, 'tis true,
I must be here confin'd by you,
Or send to Naples. Let me not,
Since I have my dukedom got
And pardon'd the deceiver, dwell
In this bare island by your spell;
But release me from my bands
With the help of your good hands.
Gentle breath of yours my sails
Must fill, or else my project fails,
Which was to please.

(Spoken by Prospero in William
Shakespeare's The Tempest.)

Figure 1.1: Graphical representation of the two lines of argumentation in this book.



Chapter 1

The nature and scope of this book

The problematic context

Under the banner of the promotion of 'management automation' in agriculture, large investments have -in the last decade- been made in the development of so-called 'information technologies' or 'management supporting systems' (NRLO, 1991) which were supposed to be used by farmers and horticulturists. However, there is widespread agreement among 'agro-informaticians'[1] that the returns on investment have been rather low, especially since far fewer farmers and horticulturists than expected have adopted such technologies (Geuze, 1991; Klink, 1991; NRLO, 1991). As I will elaborate further in chapter 2, there also seems to be a fair amount of consensus among agro-informaticians on how this situation can be alleviated. It is proposed that more comprehensive information technologies need to be developed, and that there is a need for greater coordination, standardization and uniformity in the agricultural software sector (Klink, 1991). Furthermore, it is stressed that information technologies need to become more 'user-friendly' (Hofstede, 1992; White, 1990), and that more knowledge has to be generated on decision-making processes of farmers, so that their 'real information needs' can be identified (NRLO, 1991; Geuze, 1991). Most importantly it is argued that supervision and extension activities need to be launched in order to improve the use of information technologies by farmers. The idea is that existing packages are (even if they can still be improved) quite adequate (Klink, 1991:i) and that large segments of farmers -because of their supposedly limited analytical capacities- need to be helped to interpret and analyze adequately the available information (Geuze, 1991:137; Klink, 1991:i; NRLO, 1991:10; Ziggers, 1991:12).

Two lines of argumentation

In chapter 2 of this book I will argue that the solutions presented above rest on a very shallow analysis of the problematic situation, and moreover that agro-informaticians tend to fall back on rather outdated models of agricultural technology transfer and extension. The remainder of the book, then, is dedicated to, on the one hand, the generation of a more thorough theoretical understanding of the (non-)use and development of information technologies, and on the other, the procreation of alternative practical recommendations and methods for information technology development. Thus, as is illustrated in figure 1.1, two lines of argumentation are more or less simultaneously followed throughout this book. Even though it will appear later on (see section 4.2) that I disagree with a rigid distinction between 'knowledge for understanding' and 'knowledge for action' I will speak of a '*theoretical*' and a '*practical*' line of argumentation.

In my theoretical argument I will eventually conclude that the limited adoption of information technologies can in part be traced back to fundamentally inadequate conceptualizations of knowledge, information, communication and rationality on the side of those that develop such technologies. On the basis of my theoretical explorations and empirical investigations (respectively Part I and Part II of the book) I will infer that communication needs to be looked at as a negotiation process, of which knowledge and information are an outcome. Clearly, the view that knowledge and information are constructed in a complex social setting contrasts sharply with both the transportational view of information and communication to which agro-informaticians frequently subscribe, and the related idea that knowledge can be unambiguously represented and stored in an information technology. Thus, I find it more appropriate to speak of *communication technologies*, rather than of *information technologies*.

Similarly, I conclude that not only knowledge and information are socially constructed, but also that -in time and space- communication technologies themselves are developed through an inherently politically and normatively laden process as well, and that this negotiation process may also have consequences for the use and adoption of such technologies. Another observation in relation to communication technology development processes is that commonly used procedures for communication technology development in agriculture tend to be rather deductive and inflexible. Together with the earlier conclusion concerning the social nature of communication technology development processes, this observation provokes me to conclude the practical line of argumentation with amongst others the generation of what I call a 'learning-oriented' method for communication technology development. Apart from agro-informaticians, both social scientists and prospective beneficiaries are deemed to play an active role in the negotiations which constitute such an inductive method.

A constructivist perspective

It will be clear from the above elaboration that I distance myself in this book from the objectivist or realist ontological position which assumes that "the world is composed of facts and the goal of knowledge is to provide a literal account of what the world is like" (Knorr-Cetina, 1981:1). Similarly, at the epistemological level, I reject the positivist belief that -by means of scientific procedures- we can make objective statements about the world. Instead, I adopt a constructivist stance, which posits that our understanding of the world is necessarily socially constructed. This holds not only for layman's knowledge, but also for knowledge generated by social and natural scientists. I do not dispute that there somehow exists an objective natural world. This natural world 'produces' significant triggers and feedback that human beings would be wise not to ignore. Moreover, it cannot be denied that, although mankind has learned to manipulate and predict natural processes, such processes have an autonomy of their own (i.e. they do not react to what we say about them). Nevertheless, our knowledge about the natural world can never be neutral or objective, since the generation of it is -in a particular time and space context- always connected with politically and normatively-laden problem definitions, interpretative frameworks, selections, ambitions, conflicts, goals, etc. Thus, in the analysis of social practice and events, knowledge claims with respect to the natural world (as for example incorporated in communication technologies) need to be looked at as socially constructed.

Clearly, social scientific knowledge is -in a similar vein- socially constructed as well. An important difference between the natural sciences and the social sciences, however, is that not only scientists, but also the actors which they study are actively involved in understanding and interpreting the world around them. Thus, there is -in time and space- an inherent interaction between the way in which 'ordinary' human agents act and interpret the world, and the way social scientists study this, and write and speak about it. As I will argue in the course of this book, this 'double hermeneutic' (Giddens, 1976:158) of the social sciences needs to be looked at as a strength rather than as a weakness. The methodological consequence of this phenomenon, in my view, must be that social scientists' interpretations must somehow be grounded in the experiences and life-worlds of the actors that are studied. This means that in this book I do not try to hide the interpretations that the respondents give about their own and other actors' behaviour, and that an attempt is made to study these in a contextual manner. Thus, I have adopted a case-study approach and granted primacy to qualitative methods and techniques (see chapter 6).

The social scientist as an actor and the writing of a text

The implication of the foregoing is that the researcher needs to be looked at as an active social agent in two interrelated ways. First, if there is indeed a complex interaction between the interpretations and actions of the respondents and those of the researcher, it is implied that the execution of a social scientific study in a particular context is not a neutral activity, and is bound to have social consequences of some sort. Second, if knowledge and information are socially negotiated in a particular social context, then surely this book -not unlike communication technologies- must be looked at as a carefully negotiated social construct as well. The implication of the first issue is that it is necessary to make reflections on the role of the researcher as a social actor in relation to the various case-studies that are presented (see chapters 8, 9 and 10). In relation to the second point I will -at a more general level- touch on some broader social dimensions of the research, which help to clarify in the context of which 'negotiation processes' this study was shaped, and which interests, projects, and feelings of the researcher were of importance.

First of all, it is relevant to mention that from the outset the underlying feeling of the researcher towards communication technologies in agriculture, and even agricultural extension as a whole, was coloured with scepticism. This scepticism originated primarily from earlier research experiences in Ireland, in which the inadequacy and dangers of externally-generated normative models of farming and farm development became quite shockingly clear (Leeuwis, 1989). Given the atmosphere of technological optimism and uncritical faith which surrounds the agro-informatics scene, this sceptical bias was seen as a healthy counterbalance rather than as an obstacle.

Another element that shaped my relationship with the world of agro-informatics has been that, despite the fact that quite substantial resources were available for research, it appeared to be a rather frustrating exercise to raise funds for fundamental social scientific research in this field. Although in retrospect I see it as a blessing that -as a result- I was able to remain rather independent, and could avoid getting trapped with negotiated compromises in formal projects, it did at the time generate irritation and a slight (but undeniable) wish to retaliate.

Reared as a sociologist in the Department of Sociology of Rural Development chaired by Norman Long, and also influenced by the works of Jan Douwe van der Ploeg, it is hardly surprising that my scepticism towards the practice of agricultural extension extended to the theoretical frameworks called upon in extension science as well. Nevertheless, my interest in intervention and 'practical' concerns, my wish to do research in the Netherlands, and the enthusiasm, room for manoeuvre, the chaotic, open, creative mind and generous personality offered by Niels Röling, persuaded me to take up a research position in the Department of Extension Science.

Throughout my research period I have thus been part of networks of extension scientists, rural sociologists and agro-informaticians. Being part of these three networks was not always easy; especially moving around in both the Department of Extension Science and that of the Sociology of Rural Development proved at times to be a hornet's nest. I have been jokingly (?) referred to as a 'spy', an 'intriguer', a 'deserter' and as a 'pure masochist'. Nevertheless, I have experienced this somewhat tricky position as inspiring and stimulating, even if at times it meant feeling slightly 'homeless'. At other times of course it was convenient to keep a certain distance. No doubt, this book bears traces of my position in this respect. The extensive theoretical explorations, and the themes raised in it, for example, reflect my wish to deal theoretically with and/or overcome the controversies between the various networks, and can at the same time be seen as an effort to legitimize my points of view towards the different audiences. In other words: the book expresses and is part of a discussion or negotiation process between me and actors from the various networks that I participate in.

The eventual embracing of an adapted version of Giddens' theory of structuration is but one of the outcomes of this negotiation process. To my mind Giddens' conceptualization of social systems, actors and structure could -provided that I can demonstrate its 'practical' relevance for interventionists in this book- serve as a common framework for extension scientists, sociologists, management scientists and even computer scientists. Apart from that, Giddens' framework is attractive to me personally, since it helps me to both remain optimistic about the capacity of human beings to change, and to strengthen my belief in the beauty of diversity.

Furthermore, in order to serve the reader and the scientific community at large, I have -along the two lines of argumentation- tried to order this book in a rather straightforward and logical manner. To the extent that this suggests that the research itself was carried out in an equally orderly fashion, I must warn the reader that this has not been the case. In actual practice, there has been a continuous interaction between empirical investigation, theoretical exploration, the formulation of guiding questions and reflection on practical issues throughout the research period. In my view this is inherent to undertaking explorative research, but -as Knorr-Cetina (1981) has convincingly shown- this is in fact common practice among natural scientists in experimental research settings as well. I have consciously chosen such a research strategy since there is very little empirical research and theory formation on the social aspects of communication technology in agriculture. Therefore, the issues to be studied were not clear at the outset, and it did not make much sense to design a study aimed at falsifying certain theoretical approaches. Thus, this text is a reconstruction of the research activities, which only partially reflects the actual order in which the research events and findings emerged.

A guide to the reader

I must admit that -due to the many audiences to which it is addressed- the length of this book has grown out of hand. Nevertheless, I expect that different categories of readers will find it quite easy to make selections which cater for their needs. Those readers who primarily have a practical interest are advised to focus on the sections that are part of the practical line of argumentation as indicated in figure 1.1. Similarly, those with a purely theoretical interest can follow the theoretical line of argumentation, and -like the former category- may even decide to read only the concluding sections of chapters 7 to 10, and skip the detailed empirical accounts presented in the earlier sections thereof. Furthermore, readers with an interest in empirical material on diversity within Dutch dairy farming and horticultural study clubs can concentrate on chapters 8 to 10, while those who wish to gain a fairly up-to-date overview of the Wageningen approaches in rural development sociology and extension science will have to complement this reading with parts of chapters 4 and 5. Finally, those who wish to have a broad overview of the current state of affairs with respect to the use of 'management supporting systems' in (different branches of) Dutch agriculture, and/or Dutch policies with respect to the development of such systems, will be best served in chapter 7.

Notes

1. I use the label of 'agro-informaticians' for those who are somehow professionally involved with the development and distribution of 'information technologies'. The majority of these actors -who tend to use this label themselves as well- have a background in informatics, management science, farm economics, and/or natural (agricultural production) sciences.

Chapter 2

Setting the scene

As I have indicated in chapter 1, the explorations on which this book is based originate from the widespread agreement that many private and public efforts to promote 'management automation' in primary agricultural production have failed when judged against their original objectives. In this chapter I will first take a closer look at the use of the concept of 'management automation' itself, and argue that it is in part artificial to separate it from other forms of 'automation' that are distinguished. Following this, I will in section 2.2 problematize currently proposed solutions to the limited adoption of so called 'information technologies' or 'management supporting systems' (NRLO, 1991). The aim in doing so is twofold. First, I want to point at potential practical contributions that may be derived from extension science and the (agrarian) sociology of rural development in this respect. Second, I want to identify -in section 2.3- some criteria that the theoretical framework will have to meet if we wish to improve our understanding of the use and development of management supporting systems (MSS). In order to 'wet the appetite' of the reader, I will in section 2.2 illustrate my argument with empirical experiences in the domain of agro-informatics. Some of these experiences derive from case-studies that will be presented in much more detail later on in this book.

2.1 Widening the scope of 'management automation' in agriculture'

'Management automation' is a concept of which the meaning is not immediately clear since both the terms 'management' and 'automation' have been conceptualized differently. Through time different approaches to management have emerged (Alleblas, 1987; Keuning et al., 1982; Harrington, 1991; Watson, 1986). Each approach is associated with different implicit or explicit definitions and perceptions of the activities that constitute 'management'. Many definitions of management, however, include a notion of decision making (Bemelmans, 1987; Bots et al. 1990; Huirne, 1990)[1]. The concept of 'automation' may give rise to debate as well. Generally, one speaks of automation when human activities or procedures are partly taken over by computer hardware and software (Bots et al., 1990:826), but from a more abstract point of view, it is hard to make a sharp distinction between mechanisation and automation.

In the Dutch context, a distinction is made between 3 types of automation in primary agricultural production: (1) management automation, (2) process automation and (3) automated communication (see e.g. Overbeek & Munters, 1988). Process automation refers to the automation of certain physical tasks. In process automation a computer program steers certain mechanical devices, thus performing tasks that would otherwise have to be carried out in a manner that requires more manual labour. Examples are climate computers and feed computers; the first category is meant to manipulate climatic conditions in greenhouses, storage facilities and/or animal sheds, and the latter distributes feed rations to individual animals.

It is clear that the difference between process and management automation is gradual. First, a process computer can often register data, that may be relevant information for decision making of farmers. Second, it is obvious that, for example a climate computer, does in fact automate certain management decisions; a climate computer is programmed to reach certain climatological conditions *in a particular manner*. A specific climatological condition can be reached through different combinations of interventions, and the manner in which such a condition is arrived at by a computer cannot always be influenced by a grower.

The distinction between automated communication and management automation is even hazier. Automated communication, or automated information delivery (MLV, 1984), refers to computer supported data exchange, for example through electronic networks such as videotex (see chapter 9). However, it is very hard to image the use of data that are exchanged in such a manner without a notion of decision making -and thereby management- in mind. More importantly, as I will argue later on, any software package -including those meant for 'management automation' or 'process automation'- has a communicational dimension in the sense that it communicates meanings between e.g. the software developer and the 'user'.

At this point, I will not try to give an ultimate definition of management automation. I have shown that, from a theoretical point of view, it is rather difficult to clearly distinguish management automation from other types of automation. Also, for an exploratory research it is not wise to narrow the scope at such an early stage. I will suffice by stating that management, in the context of primary production has something to do with decision making related to farming, and that automation has something to do with computers. Management automation, then, can be loosely defined as a phenomenon in which computers (are supposed to) play a role in decision making of farmers, or other actors, as the case may be.

I want to emphasize at this point that I do not wish to narrow down the idea of 'decision making' to only encompass 'formally rational' or even 'consciously reflected' decision making, but that I have a more general interest in processes that -in day-to-day practice- lead managers to take action and/or engage in certain practices.

2.2 Problematizing current solutions to the 'adoption-crisis', and the scope for additional social scientific contributions

The contributions of the social sciences in relation to management automation in Dutch agriculture stem mainly from management science, economics and related areas. Some isolated studies have emerged in extension science (Blokker, 1984) and agrarian sociology (Overbeek & Munters, 1988; Frouws & Van der Ploeg, 1988), but I think that there is considerable scope for additional practical and theoretical contributions from these disciplines[2]. This is especially so since in agriculture, as is the case in other branches (Ooninex, 1982; Lyytinen, 1987; Stamper, 1990; Vonk, 1990; Beers, 1991a), many management automation projects have failed when judged against their original objectives (see chapter 7 for an extensive overview of the history and state of the art of management automation in agriculture).

Although a large variety of management supporting systems have been developed in recent years (Klink, 1991), many of these remain under-utilized (Geuze, 1991; Annevelink & Huisman, 1991; Klink, 1991; NRLO, 1991). A considerable number of MSS are not promoted and maintained any more, and others have never been completed. Those MSS that are in operation are generally used by only a limited percentage of the farmers and/or extension workers for whom they were intended. Besides, in some cases the way in which these packages are used, does not live up to the expectations and intentions of those that developed them (Blokker, 1984; Roep et al., 1991; Leeuwis & Arkesteyn, 1991; Van Dijk et al., 1991). Furthermore, software development procedures have often been rather troublesome and -in many cases- costs have exceeded the initial budget quite dramatically. In relation to this, commercial agro-software firms seem to be loosing interest since returns on investment tends to be low.

There seems to be a fair amount of agreement among agro-informaticians on how the problems outlined above can be alleviated. In an evaluation study of the Dutch Informatics Stimulation Programme (for details see chapter 7), Klink (1991) stresses the importance of supervision and extension activities to improve the use of MSS by farmers. In addition, he argues that there is a need for the development of more formalized and structured knowledge, that can help to bring about MSS of a more comprehensive nature. That is: MSS in which different modules (e.g. relating to grassland management, breeding, feeding, administration, planning, economic analysis, etc.) are integrated, with the view of producing integral information and/or advice. In order to achieve such 'horizontal' integration, as well as 'vertical' integration of MSS within the agricultural production chain (needed to support efficiency in the chain as a whole, see Blokker, 1991) Klink argues that there is an increased need for cooperation, coordination, standardization and uniformity in the agricultural software sector. Others add to this that more knowledge needs to be generated on decision-making processes of farmers, so that their 'real information needs' can be identified (NRLO, 1991; Hofstede et al., 1991; Geuze, 1991). Also, many authors stress the importance of a greater 'user-friendliness' of MSS, amongst others through the development of suitable 'user-interfaces' (Van Himste & De Jong, 1990; Hendriks, 1990; White, 1990; Hofstede, 1992).

In the next sections I will demonstrate that the solutions presented above, and the underlying assumptions of what are and/or 'causes' the problems, are problematic and insufficiently based on empirical investigation.

Standardization as a solution?

From the early eighties onwards both the Ministry of Agriculture (MLV, 1984) and the farmers organizations (CLO, 1988) have strongly advocated the standardization of agricultural software. Thereby, the philosophy was that standardization of software was needed in order to ensure compatibility between MSS of various kinds, and originating from different software developers. This in order to prevent farmers from being 'caught' by a particular agro-software firm once they had bought a particular MSS. Furthermore, such compatibility was said to be desirable since it would allow farmers with different MSS to compare and exchange data. Also, agricultural research would presumably benefit greatly from standardized data. Hence, major efforts were launched to develop so-called 'Standard Information Models' for each agricultural branch. In these models processes at farm level are identified and unambiguously defined, as well as the data that are supposedly created and/or used in the execution and decision making related to these processes. Supposedly, these models thereby reflect the ideal 'information housekeeping' of all farms belonging to a specific branch, and private or public software developers are encouraged to adhere to these models when they develop MSS. In section 7.4 I will further elaborate on the development and use of these models; at this point suffice it to say that my study suggests that their empirical basis is rather weak, and that they are of an inherently general, subjective and normative nature. The Standard Information Models merely describe how researchers perceive the tasks and processes that farmers are performing, and what they consider to be the information that a 'good' farmer should use, produce and/or register in order to perform such tasks properly.

Empirical evidence shows, for example, that, if we stick to the Standard Information Model terminology for the moment[3], farmers and horticulturists use a *variety* of 'information models'.

Box 2.1: **Diversity, and the (in)completeness and (in)validity of information models**
It appeared that within a (at first sight) relatively homogeneous category of dairy farmers in De Achterhoek, at least six 'styles of farming' could be distinguished (see chapter 8, and also Roep et al., 1991). Each style is characterised by a specific pattern of farming that seems to be coordinated on the basis of a specific, normatively based, set of strategies. The study shows clearly that 'technical strategies' cannot be seen as separate from 'social strategies'; that is, strategies vis-à-vis the surrounding institutional environment, community, family, etc. Since the information-models as discussed above tend to be mainly technically and economically oriented, this means in fact that they are *incomplete* since farmers use other considerations (i.e. other 'entities') as well in order to guide their farming practices. Similarly, it appeared that farmers with different styles of farming tend to use different 'causal models' for reasoning about the 'same' problems, and that they conceive the problems that they are facing in a different manner. In terms of the 'information model' terminology, this means that the data used and/or generated in order to decide on a particular problem, and the 'entities', tasks and processes that they distinguish in the first place, do in fact differ systematically from style to style. This suggests that the models are not only incomplete, but that their *validity* can be challenged as well. (For further elaboration see chapter 8, section 7.4, and also Beers, 1991b.)

Another set of observations indicates that the 'information models' that horticulturists use can vary over time quite rapidly.

Box 2.2: **The limited stability of information models**
A study of enterprise registration and comparison within study clubs of horticulturists, revealed that growers constantly include (and/or have to include) new elements in their reasoning about problems and regular practices. Also, totally new problems and practices are identified on the basis of past experiences, changes in technology, environmental legislation, etc. Thus, the 'information models' they use are far from stable. (For further elaboration, see chapter 9.)

In addition, some empirical material calls into question the validity of some of the arguments used to justify standardization, and most notably those that emphasize the importance of standardization for enterprise comparison and research.

Box 2.3: **Contextuality and the illusory dimensions of standardization (1)**
Although at first sight the argument that standardization of data definitions is needed to allow for comparison of data among farms seems intuitively valid, there are problematic aspects as well. It appeared for example within the horticultural study clubs mentioned earlier, that for many parameters standard calculation procedures and formulas had been agreed upon. Nevertheless, the comparability of these parameters remained limited, since -although it was now clear how they were calculated- their *meaning* remained obscure. It could not be concluded from a sheet of paper *how* (through what practices) and in what specific *context* the parameter values were arrived at. Thus, it appeared essential to obtain all sorts of additional context information from either discussion with particular colleagues, or actual inspection and observation in their greenhouses. Thus, the 'standard' character of the parameters was in many ways an illusion. Therefore, it is questionable whether it is sensible to insist on standardization at all costs, especially when -moreover- it appears that farmers and/or growers with different styles or interests have reasons to advocate different calculation procedures.

Box 2.4: **Contextuality and the illusory dimensions of standardization (2)**
It must be noted here that some researchers seem to face similar problems with regard to the situation mentioned in the previous box. In 1988, the station for applied research in greenhouse horticulture conducted extensive statistical analyses on the basis of a large amount of enterprise registration data. They came up with a very limited number of significant correlations, which they explained with reference to the fact that the variation in production circumstances (climate, etc.) is so small that the chances of finding significant correlations are limited (PTOG, 1988:11). However, in the perception of growers, the 'variation in production circumstances' can be described as anything but 'small' (see chapter 9). The point is, rather, that the existing variation cannot be sufficiently described in terms of these 'measurable' parameters. This interpretation seems to be supported by another conclusion from the same study. It appeared that the majority of the (few) correlations that were actually found could not be interpreted, due to the interdependency of many parameters at enterprise level, and the limited number of parameters included (PTOG, 1988:11). In other words; there was a lack of context information.

A recent study by Stolzenbach et al. (1993), however, reveals that -even if farmers too value the development of a 'standard'- especially extension workers and veterinarians benefit from the introduction of standard parameter overviews and standard calculation procedures, since this makes it easier for them to make use of MSS that are developed by different agro-software firms, and that they come across while visiting different farms.

The major difficulty, however, in relation to standardization seems to result from the diversity that can be observed in the field. While I accept that 'tailor-made' software development for each farmer is unrealistic, this study will indicate that developing 'ready-made' software for a whole branch does not do justice to the existing diversity, and leads to unsatisfactory results. The 'traditional' solution to these sorts of problems in extension is to identify different target-groups. However, I will make plausible at several points in this book that current methods for identifying such target-groups are rather deductive, simplistic and therefore inadequate. Thus, one of the practical contributions I want to make in this book is:

(Practical contribution 1)
A methodology for making empirically-based classifications of farmers and horticulturists that are relevant for MSS development.

Towards more structured knowledge and integral MSS?

When MSS are developed on the basis of such (standard) information models as described in the previous section, the programmers have to define the nature of the relation between the entities in the model. Similarly, they will often want to make clear to the user what they think the user could or should do with the information offered; that is, MSS often involve a certain advisory model. Usually relationships in such models are established by means of arithmetic formula and/or Boolean rules (if-then-and-or-else statements), that are -in actual practice- often based on scientific research. Of course, the functions of the MSS can vary, and thereby the nature of the arithmetic formulas and procedures.

Box 2.5: **Different possible functions of MSS in dealing with three parameters**
If we take a simplified example concerning the relation between milk yield per cow, the amount of concentrates fed, and the type of grazing system practised, we can imagine several different MSS. One package may simulate the milk yield per cow, depending on the level of feeding, given certain other parameters, e.g. the type of grazing system practised. Another MSS may suggest an optimal mix of the three parameters, under the assumption that the profit from milk production is to be maximized. A third MSS may calculate how the actual milk yield compares to results that, according to scientific insights, could have been obtained, given the actual level of feeding and the particular grazing system practised, while a fourth MSS may try to diagnose why the theoretical milk yield has not been obtained. (I will come back to different types and kinds of MSS in section 7.3.)

Various authors have stressed that making an information model of some sort can be very instrumental for identifying areas about which limited knowledge is available (e.g. Subnel, 1990). In many ways such information models reflect the state of the art of existing knowledge (Verheijen & Eppenhof, 1989), but while making and operationalizing these models, one can easily imagine that one comes across relationships between (attributes of) entities where it is unclear whether or not they exist, let alone what is their exact nature. Of course this raises many problems if, as is the case in the Dutch context, the aim is to develop integral MSS.

The wish to make integral MSS stems from several arguments. It is argued, for example, that it is undesirable that farmers have to buy ten separate MSS -each performing different tasks- that can not communicate with each other, as a result of which farmers will have to enter the same data into each of the MSS separately (CLO, 1988). Secondly, it is argued that 'everything is related to everything' and that is exactly the power of computer-based MSS that they can help to make very complex integral decisions (see e.g. Ausher, 1991; Van Dijk, 1988; Huber, 1990). However, even if I leave aside my suspicion that, as I have suggested in the previous section, many information models are incomplete and of dubious validity, some fundamental questions remain with regard to the practical and theoretical feasibility of developing such integrated MSS.

Clearly, one of the assumptions behind the idea to 'operationalize' the relation between (attributes of) entities in a model, is that -in principle- general statements can be made on the nature of these relationships. Empirical material, however, suggests that these relationships are not unequivocal.

Box 2.6: **Diversity, and the arbitrariness of relationships between entities in a model**
Farmers appeared to not only use different entities and 'variables' (i.e. attributes of entities) when reasoning about their farms and the problems they face, but they also conceived the relationship between the 'same' variables differently. When translated to the operationalization of the relationships between entities and their attributes in an information model, this means that farmer X uses a different 'formula', with different dependent and independent variables than farmer Y for establishing the relation between, for example, milk yield and amount of concentrates fed (see also the example in the previous box). For one category of farmers, for example, the amount of concentrates fed depended on the (very high) milk yield that they -for status and other reasons- wanted to achieve, while others argued merely that the milk yield they achieved depended on the (limited) amount of concentrates that they thought was appropriate to buy while maintaining a relative autonomy from external markets and institutions. Thus, the appropriate 'formula' for describing the relationship between the two variables, seems to be context-dependent. Choosing the 'scientifically approved' formula for implementation in a particular software package, is a choice that is not neutral, since it means in fact that the package is provided with a 'code' (Frouws & Van der Ploeg, 1988; Mollinga & Mooij, 1989) that potentially makes it of differential use and applicability for different users. This phenomenon is related to the fact that scientific knowledge too is of a contextual nature (Knorr-Cetina, 1981; Latour, 1987; Callon, 1986; see also chapter 5). Hence, legitimizing such a choice by pointing to the supposedly 'objective', 'general' and/or 'superior' nature of scientific knowledge, is misleading.

Recently software developers have tried to overcome problems of diversity by increasing the flexibility and interactivity of software packages, thereby allowing users to influence criteria and norms used within the calculations made. However, the scope for this sort of flexibility seems to be limited, since it tends to increase the complexity and maintenance costs of MSS, while it does not fundamentally tackle the problem of biased formulas. If all the implicit choices incorporated in a MSS were to be explicated, and 'discussed' with the user, the MSS would become impossible to work with altogether.

If we assume for a moment that the operationalization of relationships within a model inherently results in a certain amount of bias and erroneous representations, then the development of highly complex and integrated MSS becomes problematic, since a multiplication of such errors may eventually result in totally meaningless and/or dangerously misleading figures and information. At the same time, the possibility to 'correct' may be reduced when complexity increases.

Box 2.7: **The scope for 'correcting' complex MSS**
In relation to a very complex MSS that produces both actual and normative evaluations concerning feed and fodder costs and benefits, extension workers were frequently unable to answer specific questions from farmers on how specific parameters were calculated. Both farmers and extension workers therefore frequently complained about the complexity of the package, and its almost inherent 'black box' character as a result of that (see chapter 8).

Furthermore, it appeared that -even if the calculated normative parameters were not very transparent- farmers attributed a specific meaning and importance to them. Instead of accepting scientific norms, and/or striving to achieve them, however, many farmers actually formulated and motivated their own objectives *in relation to* such norms. Their rationalizations in relation to this often clearly indicated their disagreement with (what they assumed to be) the model underlying the MSS. However, some farmers indicated that they felt uneasy when they diverted considerably from the norms, even if they themselves were quite happy with the way things were going. This indicates that some farmers may be better equipped and/or willing to 'correct' possible biases in a model than others.

Finally, there are indications that incorrect representations as produced by MSS may be rectified in interaction with extension workers and especially formal and informal interactions with colleagues, for example, in study clubs (see chapters 8 and 9).

This issue of the contextual nature of knowledge is closely related to a debate on the differences between scientific knowledge versus local knowledge (Marglin, 1991a, 1991b; Benvenuti, 1991; Warren, 1991; Richards, 1991; Mendras, 1970; Frouws & Van der Ploeg, 1988). There is considerable evidence that non-scientific knowledge is of crucial importance for both individual farmers and the agricultural sector as a whole. Also, over-scientification can be seriously counter-productive (Van der Ploeg, 1987). However, it is clear that computer programs require particular (although not necessarily arithmetic) ways of structuring and formalizing knowledge, and it is therefore not immediately evident if and how non-scientific knowledge can be integrated into MSS[4], and/or to what extent exclusion of such knowledge has adverse consequences (see section 5.1 for a more elaborate discussion of these issues).

In relation to the issues brought up in this section, the practical contributions I would like to develop are:

(Practical contribution 2)
Criteria and ideas for the design of MSS, and the organizational arrangements in which they are embedded, that facilitate a balanced integration of scientific and other types of knowledge.

The need for more involvement of extension workers?

Several authors have stressed that the availability of extension activities is a 'critical factor' for the successful introduction and use of MSS (Nitsch, 1991; Geuze, 1991; Klink, 1991). Although I have suggested already that extension workers can indeed play a role in improving the use of MSS by farmers, this conclusion derived from a different line of argumentation than the one suggested by several other authors. Most others stress that increased supervision and extension efforts are needed since -as they put it- only the 'frontrunners' or 'vanguard farmers' are able to analyze information independently (Geuze, 1991:137), that only a small percentage of farmers analyze the information that they get through MSS (NRLO, 1991:10), and/or that farmers and horticulturists find it difficult to connect the information presented with 'the' problem (NRLO, 1991:10; Ziggers, 1991:12). The implicit argument here seems to be that the available MSS are quite all right, but that farmers need to be 'educated' a little bit more in order to understand their usefulness (see section 7.2 for further elaboration on this 'user-blame' argument).

My empirical material, however, suggests that, in general, farmers are extremely busy with - and capable of- 'analyzing' and integrating the information they receive from a great variety of sources, that software developers have only to a limited extent been able to anticipate farmers' problems and information needs, and that extension workers can amongst others be particularly useful in correcting the shortcomings of MSS.

An issue that has hardly been addressed is why extension workers have so far been reluctant to get involved in supervision of MSS use. My observations give some (provisional) clues in this respect, which point to organizational problems of various types (see section 7.2 for more details).

Box 2.8: **On institutional struggles around an Irish videotex system**
In Ireland a prominent agricultural research institute introduced a videotex system in which farmers were able to pose direct questions to experts. Members of the extension service -which was at that time threatened with severe financial cutbacks, and was actually forced to amalgamate with this research institute- appeared to be reluctant to participate in this electronic advisory system. As informants at the research institute put it, they felt overruled, and were afraid that participation would result in the loss of jobs for extension workers.

Box 2.9: **On professional struggles in relation to 'Extension Supporting Systems'**
In Holland, individual extension workers were among the first to develop all sorts of small and simple programs to make their work, and especially the execution of routine calculations, somewhat easier. In response to this, considerable efforts were made to coordinate the development of (much more complex) 'Extension Supporting Systems' (ESS). Thereby, researchers have played prominent roles in the development of such systems. Furthermore, professionalization within the extension services has led to the emergence of special informatics units. As a result, some extension workers nowadays argue that they are increasingly confronted with all sorts of new ESS that they have never asked for and that increase their work load rather than reduce it.

Also, more practical problems play a role as well.

Box 2.10: **On practical problems in relation to the use of 'Extension Supporting Systems'**
First of all, many extension workers have as little education in computer use as farmers, and they do not feel very confident in using them in their interactions with farmers. Apart from that, the availability of hardware is often limited. Also, extension workers often do not know in advance what issues will be brought up by a farmer, and it is sometimes very troublesome to -in the middle of a conversation- get the computer out of the car, get the machine installed and go through a long procedure of typing in data, and asking additional questions, before an answer can be given. (Rommens, 1990).

This brings me to the contents of the available MSS. There are indications that a number of MSS do not only fail to anticipate the needs of farmers, but also those of extension workers.

Box 2.11: **The weakening of the position of extension worker as an 'expert'**
Earlier on I indicated that some MSS are so complex that farmers *and* extension workers find it difficult to properly interpret the information presented. Some extension workers expressed their feeling that failing to answer difficult questions from farmers in relation to such MSS, did not really enhance their position as an 'expert'.

Box 2.12: **Answering the researcher's, the farmer's or the extension worker's question?**
Researchers had modified a computer model that had been developed for research purposes to cater for the needs of extension workers. The MSS was able to calculate the building costs of different designs of farm buildings, given certain functional specifications. However, extension workers felt that the principal question the MSS tried to answer was never put to them in the field in that manner. In addition, the output that the MSS produced was too general for answering the specific questions that farmers did ask. Besides, after using the MSS three times, the extension workers already had a fair idea about the answer it would come up with. Thus, they never brought the MSS into the field. Instead they made several calculations for each design with different functional specifications, and put the data in a little graph, showing which type of design was -broadly speaking- the most inexpensive for different functional specifications.

In sum, the conclusion seems justified that, although extension workers may have (an) important role(s) to play, it is not immediately clear what that role amounts to, and how the cooperation of extension workers can be secured. By means of this study I hope to generate:

(Practical contribution 3)
Insight in how extension workers can contribute to the development and use of appropriate MSS, and in the arrangements needed to realize the potential contribution of extension workers.

Searching for decision-making processes and information needs?

That the information provided in MSS has to suit the needs of the prospective users is widely accepted among software developers and the importance of the idea has been stressed from the early days of 'agro-informatics' onwards. However, the present methods for identifying such information needs and for incorporating them in MSS have not led to widespread adoption of MSS among farmers. Thus, it is not surprising that strong calls are made for more systematic enquiry into farmers' decision-making processes and information needs (Schiefer, 1991; NRLO, 1991; Hofstede et al., 1991; Geuze, 1991).

In the recent past, software developers have found it rather difficult to identify information needs, for it appeared to be quite unproductive to go to a farmer and ask him or her in a straightforward manner what information (s)he needed. Apparently, it is not so easy for farmers to analyze their own information needs, and it becomes even more difficult when they have to take into account the possibilities and characteristics of an unknown technology, and the unknown motives of an interviewer. Besides, many software developers assume that they know what the information needs of farmers *should* be. Hence, information needs are often deduced from available scientific knowledge, formal rational decision-making models, legal regulations, information models, etc. I would argue, therefore, that so far information needs have -implicitly- been more or less perceived as:

'the information a farmer or grower would need if (s)he would -in relation to a specific problem (as perceived by the software developer)- make decisions in a strictly rational manner, according to the latest available scientific knowledge, in correspondence with legal regulations, etc.'

In my experience, several practical problems emerge if one builds MSS on the basis of such a conceptualization of information needs. First, we have already seen in box 2.2 that information needs are far from stable. People tend to solve problems and create new ones (with corresponding information needs) at a rate higher than most software developers can keep up with.

Box 2.13: **'Boring' MSS**

Several studies indicate that farmers become 'bored' with particular MSS because -after some time- they have internalized the useful elements that are included (Blokker, 1984; Roep et al., 1991; see also chapter 8).

The context in which farmers operate is also subject to continuous change.

Box 2.14: **Outdated MSS**

It is quite evident that the introduction of the milk quota system, and new environmental legislation have considerably altered the strategies of farmers and resulted in the emergence of new information needs. Also, more mundane changes can take place -e.g. in relation to labour availability, family composition, etc.- which affect information needs.

Hence, it is not unthinkable that assumed information needs can become outdated even before they are implemented in a MSS. Second, the enormous diversity that exists within the agricultural sector leads to the assertion that '*the*' information needs of farmers do not exist. Third, given this empirical diversity, it is rather arbitrary to use 'science' as the guiding principle for determining what the information needs of farmers should be. This point will be further discussed in chapter 5, where I will argue that, in many ways, science can be seen as just another 'local' knowledge system. Fourth, the use of formal rational decision-making models for deducing actual information needs is questionable as well. Social-psychological studies (Janis & Mann, 1977) show that different patterns of decision making exist in relation to problem solving, and that these patterns have a greater impact on actual information needs than formal decision-making models. In those patterns where one can more or less identify the phases of a formal decision-making model, it appears that these phases do not follow each other in a linear manner (Engel, 1989) and can be spread out over a wider time span. A fifth closely related point is that the concept of information needs -as it is used in practice- implies a notion of decision making and problem solving as largely individual processes.

Box 2.15: **The social nature of 'information needs'**

One of the case-studies in this book shows that information needs are shaped and fulfilled in social interactions in which issues of power and interests play an important role (see chapter 9).

Box 2.16: **On social networks, the ideology of the 'Information Society', duplication and disappointment**

Another study on the introduction of an electronic communication network shows that farmers and growers are part of quite elaborate social networks, in which information needs arise and are catered for. Its initiators aimed at providing as wide as possible a range of information through this network. The study showed that both the institutions and the farmers participating in the network did in fact have very few explicit ideas about what information services the network should offer. A main reason for both parties to participate was in fact the expectation and belief that such a communication network would prove to be of critical importance in the 'information society that is to come'. As a result of this lack of concrete ideas, many participants were disappointed with both the number of services offered through the network, and their usefulness.

More generally, it seems rather strange that many software developers seem to take as a starting point that their software packages have to provide 'all the information a farmer may need in a particular problem situation'. In fact this means that a considerable amount of duplication may result. It is by no means clear that MSS add sufficient value to compete successfully with existing knowledge and information infrastructures (see Van Dijk, et al., 1991).

The basic problem that underlies many of the issues raised in this section is that information needs have essentially been deduced from models and assumptions that are insufficiently supported by empirical evidence. Thus, one of the purposes of this study is:

(Practical contribution 4)
To develop an empirical and inductive methodology for identifying information needs that can be expected to have a long-term relevance for particular groups and/or categories of farmers.

Creating user-friendliness through better user-interfaces?

The design of a good user-interface is generally considered important for increasing the user-friendliness of computer programs. The term 'user-interface' refers to the way in which the users and a computer program 'communicate' with each other. Thus, discussions about user-interfaces frequently focus on issues such as screen lay out, graphics, menus, colours, windows, semantics, syntax, dialogue, etc. The study of user-interfaces has become the domain of especially cognitive psychologists and cognitive ergonomists (e.g. Moran, 1981; Schneiderman, 1980, 1987; White, 1990; Willems & Lindijer, 1988). Many authors generate checklists of guidelines for building suitable user-interfaces (Bemelmans, 1987; Hofstede, 1990a). These lists, according to Hofstede (1990b), commonly stress the importance of consistency, simplicity, and the availability of feedback facilities and 'undo'-opportunities.

However, several authors point out that the importance of a good user-interface should not be overstated (Hofstede, 1990b; Leeuwis, 1990). Referring to Jörgensen (1987), Hofstede (1990b) states that users prefer to continue working with a 'bad' interface that they are used to, than learning to work with a new one. He also points out that many experiments in this field contradict each other, and he concludes that apparently the specific context plays an important role, and that therefore general guidelines are hard to formulate. Finally, Hofstede stresses the importance of improving software development procedures as a prerequisite for enhancing both the contents and the user-friendliness of MSS.

Box 2.17: **Troubled distinctions between 'form' and 'content'**

In fact, the difference between user-friendliness (the 'form') and usefulness (the 'contents') is sometimes rather hazy. Imagine a videotex database in which the pages can only be accessed through a lengthy tree-like menu structure. In a system like this, it is very difficult to find all the pages with relevant information on, say, car insurances. If we include search facilities on specific key-words in order to allow for more efficient access to pages, do we improve user-friendliness, or have we fundamentally changed the functionalities and nature of the database? After all, the user can now easily compare offers from different participating insurance companies, and at the same retrieve an evaluation by a consumer organization. Thus, from the perspective of insurance companies, the nature of the database may have changed considerably.

In this study, I am not interested in the 'user-interface' in the narrow sense described above. Rather I would like to broaden this concept. In the first place, the term 'user' is not unambiguous. In agro-informatics the farmers are usually referred to as the 'users'. But would it not be equally valid to argue that it is the government and the farmers organizations that want to *use* MSS to improve the competitive position of certain segments of the Dutch 'knowledge intensive' agricultural sector; or that researchers and extension workers *use* MSS to promote their (often scientific) models of farming; or that it is agro-industry that wants to *use* MSS to integrate production chains, tie customers and increase margins? There often is a whole network of actors who want to 'use' a MSS in one way or another. Second, there are many more interactions which are relevant to the use of a MSS than the 'communications' between the actual system and the user. A MSS is usually marketed and supported (e.g. by extension workers) within a specific context and organizational set-up. Also, during the development phase of a MSS, interactions with the prospective 'users' may or may not take place. Thus, I will argue in section 6.1 that MSS do not just have a (more or less problematic) software technical 'user-interface', but that they emerge at, constitute and/or (re)produce particular 'social interfaces'[5] (Long, 1989). In relation to this they do not only have an '*internal*' (i.e. software technical) design, but also a more or less explicit '*external*' design (i.e. they have a social 'code', and are organizationally embedded in a particular manner; see section 7.3). Here I will briefly discuss an important element of such 'external' designs, namely the procedures through which the MSS is developed.

In extension science 'client orientation' is considered to be one of the most important prerequisites for the delivery of adequate information and/or technologies (Wapenaar et al, 1989). Client-orientation, then, can be increased through user-research and user-influence. The interest in Participatory Technology Development (for an overview, see ILEIA, 1989) and Farming Systems Research (Shaner et al., 1982; Fresco, 1986), must be seen in this context, but has been almost exclusively dealt with in the context of technology development in 'developing countries'. Within informatics, however, several people have stressed the importance of user-participation in MSS development as well (Hofstede, 1990a, 1990b; Leeuwis, 1989; Gould, 1987; Nielsen en Molich 1989). Experience shows, however, that effective 'user-participation' is not easily achieved.

Box 2.18: **How to achieve effective participation? (1)**

An arable farmer in the North of Holland, in his spare time a fanatic computer hobbyist, developed his own private MSS. A commercial firm wanted to sell his package to a wider audience. The employees of the firm figured the package had to be slightly adapted, but when they started to 'improve' the package, the arable farmer was confronted with changes that, according to him, were foolish and reflected a complete lack of insight into arable farming. They then employed the arable farmer on a temporary and part-time basis to provide advice on the changes to be made, and to explain to them the logic of the package. However, when the commercial MSS had been completed, the arable farmer still preferred to use his own 'outdated' version.

Box 2.19: **How to achieve effective participation? (2)**
In the horticultural branch, two MSS were developed simultaneously in order to support the registration and comparison of data within horticultural study clubs. Both development 'projects' were initiated by growers themselves. In both cases, members of the horticultural community participated in the development process. The results of these projects, however, were very different. In several ways, the MSS that had been developed on an extremely low budget, through a very informal process and with a very limited knowledge of software development principles, appeared to be superior to the MSS that was designed with a considerable subsidy, and with usage of accepted software development methods (see chapters 9 and 10).

In conventional software development methods (see e.g. Bots et al. 1990; Bemelmans 1987; MLV, 1987a; and for more details, chapter 7), little attention is paid to user-participation and user-research. In other approaches, such as prototyping (Vonk, 1990), user-participation is a central element. Although insights arrived at within the prototyping tradition of software development are certainly important for my study, I suspect that the agricultural sector has characteristics which render existing prototyping procedures unsuitable for direct application. Conventional software development methods, including prototyping, are often geared to the development of 'tailor-made' software within a specific organization. In such organizations, the idea of what is to be achieved is often -at least officially- quite clearly defined. Moreover, hierarchical structures allow for more or less effective control of the achievements of the organization. Furthermore, there is usually a real demand from within the organization -even if it may be controversial- that triggers off the development of a MSS in the first place. In addition, there are usually highly educated (prospective) users in the organization who can effectively communicate with software developers. This contrasts sharply with the agricultural sector, in which MSS are usually of a 'ready-made' nature, and where much diversity exists. Moreover, the demand for the development of MSS originates largely in agricultural policy, research and extension circles, while prospective users often have little experience with computers.

The contribution I want to make in relation to this is:

(Practical contribution 5)
An assessment of: (a) the types of user-research and user-influence that are required in agricultural MSS development; (b) the ways in which they can be incorporated into MSS development methods; and (c) the conditions under which user-research and user-influence are likely to be effective.

2.3 Conclusion: central concepts for understanding the use and development of MSS

In this chapter I have tried to generate some queries in relation to the conventional problem definitions and proposed solutions concerning the development and use of management automation in primary agricultural production. In essence, I have challenged the *unilinear models* of, on the one hand, farm development and, on the other, knowledge generation, exchange and utilization that seem to be implicit to these problem definitions and solutions. The emphasis on standardization and the development of integral MSS, and the lack of attention for diversity which transcends the 'frontrunners' and 'followers' categorization, for example, clearly reflect the idea that agricultural development should follow one particular course, and that -in a particular context- there is only one most rational pattern of farm organization. Similarly, amongst others the prominence of scientific models in MSS, the roles attributed to extension workers and the limited concern with user-research and user-participation reflect a linear way of thinking about knowledge generation, exchange and utilization as described by Röling (1991:13-14). Some of the assumptions that Röling connects with this linear mode of thinking seem indeed common sense among agro-informaticians, such as the idea that technology is 'applied science', and the belief that relevant innovations are produced by scientists, disseminated through intermediaries, and used by beneficiaries.

In the last decade both modes of linear thinking have been extensively criticized (see Röling, 1988, 1991; Kline & Rosenberg, 1986; Chambers et al., 1989; Richards, 1985; Van der Ploeg, 1987, 1990a), and by and large the questions raised in this chapter run parallel to such criticisms. At this point, I would like to -at a more abstract level- reflect on the elaborations in this chapter, with the view of identifying concepts that a more adequate theoretical framework would need to incorporate and connect with each other in order to further our understanding of the development and use of MSS.

A first observation is that many problems related to the use and development of MSS are of an *interactional* nature. On the one hand we are dealing with problems of interaction between human actors and computer-based MSS, and on the other it has become clear that these need to be looked at in the context of interactions between a *variety* of actors. It has emerged, for example, that the effectiveness and efficiency of interactions between MSS and farmers can vary according to the quality and nature of interactions between farmers and extension workers; between farmers and software developers; between software developers and extension workers; between farmers and suppliers of inputs; and between farmers and other sources of information.

Second, it is already clear from the previous observation that specific interactions need to be understood in their *historical* context.

Third, to the extent that these interactions are problematic, many difficulties centre around the *communication* of *meanings*: software developers find it difficult to understand what the information needs of farmers are; farmers and extension workers have difficulty in interpreting the information produced by a MSS; researchers develop MSS that fail to anticipate the reality of a farm as perceived by the farmer; and software developers continue to draw on linear models, even if social scientists try to tell them to do differently; etc.

Fourth, several problems seem to be related to issues of *power*: farmers and software developers have different levels of influence on the nature and contents of MSS; state-subsidized organizations have the resources and interest to enforce a certain level of standardization; extension workers are put under pressure to use certain MSS; etc.

Fifth, several observations cast doubt on the value of *rational decision-making* models: such models appear inadequate for describing actual processes of decision making; the existence of strategic diversity suggests that different valid rationalities may coexist; there are indications that in practice decision making is not an individual process; etc.

Sixth, the use and development of MSS seems to have a *normative* and *ideological* dimension: diversity among farmers is partly based upon different ideas on what is 'good' or 'bad' farming; investments in MSS cannot be properly understood without recognizing that actors have a strong belief in their future importance; efforts to make integral MSS are related to convictions concerning the value of scientific knowledge and the required direction of agricultural development; etc.

In my view these observations and reflections can be summarized and integrated into two crucial requirements a theoretical framework for understanding the use and development of MSS will have to meet. First, it needs to allow us to understand interactions in which MSS play a role in the (historical) context of a complex social setting in which a *variety* of social actors are *actively* engaged. Second, it should help us to conceptualize the *social* dimensions of knowledge, information, communication and rationality. That is, it needs to make clear how both rationality and the communication of meaning (and thereby the generation and transfer of knowledge and information) are intertwined with the operation of power, social norms and ideological convictions. In search of such a theoretical framework, I will explore several scientific fields of study in Part I of this book.

From 'management supporting systems' to 'communication technologies'

Clearly, when discussing a variety of scientific fields of study and theoretical approaches there is a considerable risk of ending up with a Babylonical confusion of tongues. So far I have conformed to literature in the field of agro-informatics and used terms such as 'management automation', 'information technologies' or 'management supporting systems'. However, even within this domain there is no generally accepted terminology, and across the different fields of study that will be covered in Part I the variation is even larger. A multitude of labels -such as 'information technologies', 'information systems', 'computer-based systems', 'knowledge systems', 'communication technologies', 'computer technologies', etc.- are used to refer to basically the same phenomena.

For understanding situations in which computers (are supposed to) play a role in farmers' decision making I think that the term '*computer-based communication technologies*' would be the most appropriate label. The centrality of 'communication' in this description highlights the interactional nature of these phenomena and problems related 'computer-mediated decision support', and is in line with the concepts that I have identified as crucial for understanding these. Thus, I propose to see 'information technologies', 'information systems', etc., as technologies with the help of which actors (be they researchers, farmers, extension workers, or software developers) deliberately try to communicate certain meanings to others. A similar view has been adopted by Winograd & Flores (1986:123,176) who describe a computer as a "structured dynamic communication medium" (1986:176).

The communication of meanings, then, does not necessarily have to take the form of clear-cut 'messages', but can also be more implicit. A software design, for example, can be seen as depicting a particular ordering of the world as meaningful, or -to the extent that certain (farming) practices are automated- as proposing that particular management decisions can be sensibly taken over by models that have been developed by others. Thus, from now on I will speak of 'computer-based communication technologies' or -more conveniently- of '*communication technologies*'. Thereby, I use the term to both encompass what is generally labelled the 'computer hardware' (i.e. the 'material' dimensions of the technology) and the 'computer software' (i.e.the programs that are written to be 'run' on a particular piece of hardware)[6]. Similarly, for reasons expressed in section 2.1, I speak of communication technologies equally where others wish to separate between 'management automation', 'process automation' and/or 'automated communication'.

Notes

1. Bemelmans (1987:1) describes management (besturen) as "planning, organizing and controlling the execution of goal-oriented activities (transl. CL)", and adds to this that this implies that management needs to be looked at as a continuous decision-making process. Bots et al. (1990:828) directly equate management to "the decision-making process", while Huirne (1990:7), with reference to Kay (1986), describes management as "the decision-making process in which limited resources are allocated to a number of production alternatives". These conceptions of management seem to depict management as a largely individual and rational activity. In later chapters I will challenge such conceptualizations of management.

2. Blokker (1984) has conducted a decision oriented evaluation study of a particular crop-protection software package (EPIPRE). Although many of the insights developed in this study remain useful, there is a need to reconsider some of the results in the light of recent developments related to management automation in agriculture. Also, I feel that further elaboration is required on the theoretical and methodological consequences of some of the issues brought up by Blokker. The latter remark holds for the study by Frouws & Van der Ploeg (1988) as well. In their critical account they argue that automation tends to reinforce models of agricultural development that are increasingly outdated. Also, they point to the shortcomings of the 'scientific rationale' that seems to underlie many automation efforts, and they use the fairy tale of the "emperor without clothing" as a metaphor in order to describe the state of the art of automation in Dutch agriculture (1988:78). They call for a different, more creative application of computer-technologies, but they do not give clues on the directions and/or methodologies that could be followed to arrive at such applications. The focus in the study by Overbeek & Munters (1988) is on the effects of automation on both the agrarian structure, and farmers/labourers in the sector, and is less concerned with the knowledge processes on which I intend to focus in this study.

3. It must be noted that, in the Dutch context, the term 'information model' is almost exclusively used to refer to the Standard Information Models. However, in fact any computer program incorporates a certain model that relates certain entities (that is, 'objects' in relation to which one would like to register or calculate specific data/attributes; e.g. 'a cow' and its 'milk yield') with others. Several methods for 'data modelling' have been developed (see Bots et al., 1990), and the approach adopted for the development of the Standard Information Models is just one of them (see section 7.4).

4. Frouws & Van der Ploeg (1988:54) argue that computers presuppose scientific knowledge, and that what they call 'art de la localité' cannot be put into a computer. Furthermore, they illustrate how efforts to transform 'art de la localité' into scientific knowledge by means of a Delphi-method (Van Houten, 1989) ran into trouble (1988:59). However interesting their contribution may be, the sharp distinction they (and others e.g. Marglin (1991a, 1991b) seem to make between scientific and non-scientific knowledge is problematic. In chapter 5 I will argue that scientific knowledge, in many ways, is just another type of 'local' knowledge.

5. Social interfaces are defined by Long (1989:2) as: "critical points of intersection or linkage between different social systems, fields or levels of social order where structural discontinuities, based upon differences of normative value and social interest, are most likely to be found."

6. Although the distinction between 'hardware' and 'software' may at first sight seem rather straightforward, at second thought it is not. It has been documented that 'physical' technologies carry within them a 'societal code' (see e.g. Mollinga & Mooij, 1989; Kuitenbrouwer, 1975; Winner, 1985). In relation to computer hardware it can, for example, be argued that it reflects and promotes 'digital thinking' in Western societies, and/or that it is an expression of societal interests in speeding up certain activities, or reducing the dependency on human beings and human effort.

Part I

THEORETICAL EXPLORATIONS

Introduction to Part I

In Part I (chapters 3, 4, 5 and 6) of this book I will search for a theoretical framework that meets the criteria that were formulated in the concluding section of chapter 2. In the process of doing so I will evaluate currently used frameworks for understanding the use and development of what I have called 'communication technologies' (CT). In agro-informatics prevailing approaches derive mainly from computer science, management studies, farm economics and natural (agricultural production) sciences. Clearly, both the first prerequisite (i.e. that the framework should allow us to understand de use and development of CT in the context of a complex social setting in which a *variety* of actors are *actively* engaged) and the second (i.e. that it should help us to understand the social dimensions of knowledge, information, communication and rationality) express my conviction that present approaches can be suitably enriched with insights from communication science and sociology. As several authors (e.g. Steinfield & Fulk, 1990; Walsham & Chun-Kwong Han, 1991) have indicated, theory formation in communication science and sociology with respect to the development and use of CT is in its infancy. Hence, I cannot suffice by referring to existing approaches only, but I will have to explore the consequences of more general frameworks that are not usually associated with the study of the use and development of CT as well.

Below, I will identify in more detail the disciplines or fields of study that I will incorporate in my theoretical explorations.

Disciplines under investigation

In section 2.3, I have derived the two prerequisites that the eventual theoretical framework will have to meet from a series of concepts which -on the basis of some initial empirical experiences- seemed important for understanding the use and development of CT. Thus, I am primarily interested in disciplines and theoretical approaches that make statements about the complex interrelations between concepts such as social interaction, context, knowledge, information, communication, meaning, power, social norms, ideology, decision making and rationality. In relation to this, the disciplines or fields of study that seem most relevant are the following.

In chapter 3, I will discuss the two disciplines that lie at the root of the introduction of CT in agriculture; *informatics* (or *computer science*) and *information systems research*. It can be safely presumed that computer scientists have developed implicit or explicit definitions and assumptions with regard to the concepts that I am interested in. Exploring these conceptualizations may indeed increase our understanding of the nature of contemporary communication technologies in primary agricultural production, since a fair number of agro-informaticians have at least a partial background in computer science.

The major concern within *information systems research* (or *information management studies*) is how the supply and demand of information in organizations can be mediated with the help of CT. Thereby, much attention is paid to decision-making processes and software development methods. Thus, conceptualizations of the interrelations between decision-making, the nature of human interaction in organizations, knowledge and information are bound to be central to this domain.

In chapter 4, I will discuss conceptualizations that derive from various branches of *communication science*. Studies in the field of *computer mediated communications in organizations* focus primarily on change processes in organizations that accompany the adoption of communication technologies. Hence, various authors in this field have explicitly developed theoretical frameworks that link concepts such as decision-making, social interaction, communication, information, meaning, power and social norms.

Not unlike the previous branch mentioned, *extension science* has historical roots in studies on the diffusion of innovations (Rogers, 1983), and has -at least in the Netherlands- become increasingly interested in advisory communication, voluntary change, (participatory) technology development, social learning, and themes similar to those raised in the field of communication technologies in organizations, but then at an inter-organizational level. Thus, extension scientists too deal with most of the central concepts identified earlier on.

In chapter 5, I will proceed with identifying contributions from *sociology* for understanding the interrelations between the central concepts. First, I will explore the *(agrarian) sociology of rural development*, in which rural change and the processes through which it takes place are key 'objects' of study. The development and introduction of new technologies, as well as other external interventions have therefore received considerable attention within this field. Thus, an exploration of this discipline can be expected to yield insight into the particularities of the rural and agricultural context with respect to the phenomena and concepts that are of interest.

At a more general level benefits may be derived from *general sociology* and the *sociology of knowledge/science*. Social interaction and social order are fundamental concerns in general sociology, and especially concepts such as power, social norms, meaning, communication, rationality and contextuality are central to it. Furthermore, insights derived from this discipline may help to connect the 'micro' processes that I will deal with throughout this book, with phenomena at 'macro' level. The sociology of knowledge deals more specifically with processes related to the production of knowledge and information in social interaction and society at large, and is therefore of immediate interest to this study.

It will be clear that, in the context of this study, it is impossible to present a complete and comprehensive overview of the fields and disciplines listed. I will focus on those theoretical approaches within them that seem the most interesting and/or relevant to this study, and briefly position them against other approaches in their respective fields.

Chapter 3

The origins of communication technology: approaches within informatics and information systems research

3.1 Informatics or computer science

Computers are described by Van Ammers et al. (1991:11) as symbol-manipulating artefacts. The first mechanical devices that could be programmed to do so originate from Charles Babbage's design of the Analytical Engine and the writing of programs for this machine by Lady Ada Lovelace. At present we have arrived at the development of fifth generation computers, and 'artificial intelligence' software techniques (see for a more detailed historical overview Van Ammers et al., 1991:14-17).

Parallel to the development of software and hardware techniques there have been numerous philosophical debates on for example the question whether or not machines can think (Turing, 1950), on whether or not the human mind can be simulated by machines (Lucas, 1961; Good, 1969; Hofstadter, 1988), on the differences between intelligence and 'artificial intelligence' (Mars, 1987; Findler & Meltzer, 1971; Van den Herik, 1988; Hofstadter, 1988; Winograd & Flores, 1986; De Swaan Arons & Van Lith, 1984). Many of these issues are still controversial, and it is not my aim to add much to these debates. In this book the concern is not so much with the philosophical problems in relation to computers (or communication technologies as I have described them), but rather with the practical and sociological ones. I therefore have a special interest in the way in which information, knowledge and communication are conceptualized within informatics.

Informatics on information and communication

Informatics, according to the Académie Française -as cited by Van Ammers et al. (1991:3)- is the field of study that encompasses "the theoretical and practical aspects of the processing - especially by means of automated devices- of information, viewed as the formal expression of knowledge and communication, in all areas of society" (transl. CL). This definition implies either that information is something that can be formally expressed, or that informatics limits itself to the kind of information that can be formally expressed. Whatever the case, it is clear that this definition suggests that information can be seen as something that can exist independently from human beings. Other definitions used in informatics seem to suggest a more subjective interpretation of information. Van Ammers et al. (1991:28), for example, define 'information' in the following manner: "a message contains information about a system only then, when it *adds to* the receiver's knowledge concerning the state in which that system is in" (transl. CL). This definition implies that information has a subjective nature, since -in principle- it allows for a discrepancy between the meaning or interpretation assigned to it by the source, and the one attributed to it by the receiver of information. However, in informatics, such discrepancies are usually described in terms of 'noise' and 'distortions' that occur in the transmission channel (Van Ammers et al., 1991:23), rather than as a fundamental characteristic of information itself. Thus, in essence information remains an objective phenomenon (or even a commodity). This becomes even more apparent from the observation that in computer science the information content exchanged in a communication process can be quantified and measured.

In informatics, information content is measured in *bits*; whereby 1 bit is defined as "the information content of the smallest possible system with uncertainty; that is, a system with only two possible states" (Van Ammers et al., 1991:31; transl. CL). For discrete systems the information content of a system F(N) can be described as $^{2}\log(N)$ bits, in which N is the number of states the system can have. The information content of continuous systems can be calculated in a similar fashion by treating it as a discrete system, and establishing the number of states it can have by assuming an interval for which it becomes impossible to distinguish one state from another (Van Ammers et al., 1991:29-32).

From an informatics perspective, such a mechanistic and mathematic conceptualization of information may have numerous practical and theoretical advantages when it comes to the development of adequate (e.g. fast, compatible, efficient, reliable, effective, accessible, etc.) software and hardware packages. This may be quite all right as long as one looks at internal communication and transmission processes within such a software and hardware package, but it becomes problematic when interaction between human beings, or between human beings and software and hardware packages is involved. This can be elucidated by building on an example that Van Ammers et al. (1991:28) give to illustrate what information is from an informatics perspective.

They assume a telephone conversation between the reader and his or her colleague in London. After a while the colleague mentions that "it is raining cats and dogs", and a few minutes later the colleague mentions that "the streets are wet." According to Van Ammers et al., the first statement increases our knowledge of the system "London", and can be characterized as informative, while the second statement can not because nothing new is mentioned. From a social science perspective such an interpretation can be challenged in various ways.

First, the second statement may allow the receiver to draw conclusions with regard to the state of mind of his or her colleague; the receiver may now, for example, have an image of the sender as someone who is absent minded for some reason and melancholically stares out of the window, looking at the rain.

Second, it may be that the second statement gives the receiver a clue about the importance the sender assigns to the observation that it is raining, or -in a totally different context- (s)he might actually start wondering whether or not the statement is true, given the fact that the colleague gives it so much attention. The receiver's interpretation of the urgency and meaning of the repeated message indicating that it is raining, may also be influenced by the conversation that went on previous to it, as well as by the fact that the sender chooses the telephone (and not another medium) to express it.

Third, if we imagine the receiver to be a foreigner whose experience in English is not sufficient to know that "raining cats and dogs" means "raining very hard", the second statement may indeed help to properly interpret the first.

Fourth, the additive and uncertainty-reducing nature of knowledge and information can be questioned with this latter example as well; if the expression "raining cats and dogs" would lead the receiver to think that cats and dogs are literally pouring down from the air, it may raise a lot of questions and create considerable confusion and uncertainty with regard to previously unproblematic assumptions in relation to English weather conditions. A similar effect might occur if the receiver of the message was a scientist who had developed a climate model which predicted with 99% accuracy that it would not rain in London, and the telephone call was actually meant to test the validity of this model.

As appears from this discussion, the differences in meaning and meaningfulness of a particular message can be influenced by many factors that go beyond 'noise' and 'distortions' in the transmission channel and have to do with the particular context in which the interaction takes place, as well as the wider frames of reference, previous experiences, etc., on the side of the receiver. Thus, it is a problem that informatics makes no fundamental distinction between communication between (or within) machines and that between human beings, or between human beings and machines. Van Ammers et al. (1991:23) describe communication as "all forms of interaction between two systems (e.g. people, machines, organizations) in which *messages* are exchanged". According to them such messages (consisting of a row of symbols) are formulated on the basis of an information source, and transformed (encoded) by a sender into a *signal* that is transferred through a *transmission channel* (at which point distortions and noise can occur), after which it is reconverted (decoded) into a message by the receiver. A very similar conception of communication can be found in Davis & Olson (1985:203). Such views of communication ignore the historical context in which the communication takes place, the goals and interests of the participants, the frames of reference that they can draw upon, the reason for which a particular medium is used, etc. At the same time, I have shown that such aspects may be relevant for understanding communication processes in which human actors are involved.

Informatics on knowledge and knowledge representation

Related to the conceptualization of information in informatics, are assumptions about knowledge. In computer science a commonly made distinction between data, information and knowledge is, that data are the input into a computer program, that information is the (interpreted) output, while knowledge is built into the program in order to generate information out of data. This information, then, will hopefully result in an adaptation of the users knowledge. In an essentially similar vein, Jorna (1992a:45) speaks of data as facts, of information as interpreted facts, and of knowledge as inferences of information, that can - amongst others- be incorporated in computer programs again.

Apparently the assumption is that knowledge can be represented in such a way that a software and hardware package can work with it. There are several ways in which knowledge can supposedly be represented in such communication technologies. 'Conventional' computer programs, for example, usually comprise arithmetic procedures (involving arithmetic operators such as +, -, :, x, etc.), and Boolean statements (involving Boolean operators such as if, then, else, and, or). Thus, these programs perform certain calculations (often referred to as algorithms[1]); that is, sequences of unambiguous steps that are performed to reach a solution to a particular problem. Given certain input data it is simply a matter of executing a predetermined procedure to arrive at a solution.

However, as De Swaan Arons & Van Lith (1984:16) point out a purely algorithmic approach can sometimes be problematic for several reasons. First, such a 'brute force technique' cannot handle problems in which the options that are to be evaluated are almost limitless, as is the case with, for example, chess. Second, there are domains that are not very suitable for the development of algorithms (e.g. medical diagnostics). As response to such problems, knowledge representation methods and techniques were developed that are assumed to more adequately resemble the reasoning of human beings, e.g. the chess player or a doctor. In this domain of 'artificial intelligence' it is taken as a starting point that such experts reason in an inexact manner, based on previous experiences which are reflected in rules of thumb. Therefore, the basic ingredient of computer programs built in this tradition (commonly labelled Expert Systems, Knowledge Systems or Rule Based Systems) are heuristic statements rather than algorithms. In essence, most Expert Systems consist of a so-called knowledge base and an inference mechanism. The knowledge base can in turn be divided into a rule base in which rules of thumb are expressed in IF-<criterion>-THEN-<action>-<certainty factor> statements, and a data base that consists of frames in which the necessary information related to the facts that are referred to in the rules are stored. This data base can be organized as a semantic network that describes entities and the interrelations between them. The inference mechanism is a program that allows for a specific way of reasoning with the rules and data that are provided by the database/semantic network and/or interactions with the user (see De Swaan Arons & Van Lith (1984) and Jorna & Simons (1992) for more detailed elaborations on these systems).

Important advantages of such Expert Systems are thought to be both the fact that less formal types of knowledge can be incorporated as compared to algorithmic systems, and that, in principle, it is possible for the program to explain how (through what rules) it arrived at a conclusion. However, in practice many problems still exist with regard to these types of programs, especially in relation to the process of knowledge acquisition (the tapping of rules from one or more experts, see e.g. Van der Werff, 1992) and the generalization and validation of the outcomes generated by the system.

A common characteristic of above mentioned forms of knowledge representation (arithmetic formula's, Boolean statements, IF-THEN rules, databases, semantic networks, frames, etc., see also Jorna, 1992b) is that they are built on at least two assumptions: (1) Knowledge relevant to problem solving in a particular context exists independently from human beings. Even if an Expert System is supposed to reflect the expertise of one particular person this assumption is often made by the developers since an Expert System is usually meant to make specific expertise accessible to a wider audience that can fruitfully use the expert's knowledge in similar situations. In essence, this means that the existence of an objective reality that can be objectively understood is assumed (see e.g. Jorna, 1992a). (2) It is assumed that relevant knowledge can be explicated and unequivocally represented by means of symbols and/or languages that adhere to a certain syntax.

In the social sciences such assumptions and conceptualizations are far from generally accepted. As I will show later on many social scientists perceive knowledge as an inherently social phenomenon, that exists only in peoples minds (Berlo, 1960; Schutz & Luckmann, 1974; Arce & Long, 1987; Röling, 1988; Leeuwis et al., 1990), and the existence of a reality that can be objectively known is the subject of hot debates (Feyerabend, 1975; Latour, 1987; Amsterdamska, 1990; Callon, 1986a; Knorr-Cetina, 1981a). Similarly, as for example Giddens (1976) has argued, people make use of many rules of interpretation that they are unable to explicate.

Of course, it is hardly surprising that prevailing conceptualizations of knowledge and information in informatics differ from those adhered to in certain branches of sociology and communication science. Even if the definitions used in computer science may be powerful when dealing with processes *within* software and hardware packages, I have the impression that they are less adequate when interactions between such communication technologies and human actors are concerned. Thus, an interesting issue that emerges is to what extent problems related to the development and use of CT in agriculture can be explained by inadequate conceptualizations of knowledge, information and communication on the side of those that are involved in developing them.

3.2 Information management studies or information systems research

The field of information management studies or information systems research covers a wide area. In this section I will focus on the different theoretical approaches within this field with regard to the nature of management, organizations and human decision making. In doing so I will touch on many of the important concepts that were deemed relevant to the area of study. The generation of methods for the development of communication technologies (commonly referred to as Management Information Systems and/or Decision Support Systems within this field) forms another important theme within this discipline. These methods are widely used in the domain of agro-informatics and will be discussed in chapter 7.

The nature of management in organizations and the role of (communication) technology

Insights and methods developed in information management studies have been predominantly developed on the basis of empirical research and experiences within organizations. It is important to note at this point that farms, although they have organizational characteristics, tend to differ from the type of organizations in which these insights have emerged. Farmers, of course, have to take very complex management decisions with regard to the organization and coordination of a large number of activities. However, most farmers in Holland have no, or only very few, employees. In many cases the family is the major source of labour. In contrast to organizations and production processes in which many more people are directly involved, communication lines are very short in most farms, and decision making and information gathering are highly centralized activities. Of course, farmers do not work in isolation from other farmers and institutions around them, so we might see farmers as members of an organization called 'the agricultural sector' or 'the agricultural production chain'. However, even if sociologists (e.g. Benvenuti, 1982; Van der Ploeg, 1990) have shown that surrounding institutions can have considerable influence on the way farmers organize their work, we must keep in mind that farmers are usually not employed by those institutions and that the nature, logic and extent to which farmers can be controlled by institutions may be quite different from what occurs in corporate contexts[2].

It is no surprise that schools of thought with respect to management are closely linked to different approaches in organization theory; after all, ideas about what should be managed in an organization, and how, must be closely related to a perception of what an organization *is*. Commonly used labels in both management and organization theories are the 'scientific approach', 'human relations approach', 'process approach' and 'systems approach' (see e.g. Watson, 1986; Harrington, 1991; Alleblas, 1987). I will use a classification used by Harrington (1991), who -following Watson (1986), and in a similar vein as Morgan (1986)- groups the different approaches under three different metaphors and identifies the respective views on organizational structure and the meaning of (communication) technology in organizations[3]. Harrington is especially interested in the relationship between communication technologies and organizational structure, defined by him as 'linkages' within an organization (1986:49). His exploration of different approaches shows that within the different schools of thought a different emphasis is put on the nature and type of linkages that exist and/or are deemed relevant, and thus that the perceptions on structure vary.

First wave
The first wave of approaches can be captured by the metaphor of 'organizations as machines'. In these approaches, an organization is seen as something that can be controlled and designed in order to attain certain predetermined objectives in a rational manner. In these approaches (communication) technologies are seen as fully controllable tools and resources in the hands of managers for the design and control of an organization. Within this category of approaches Harrington considers two main variants: (a) the scientific approach, and (b) the administrative principles approach.

The main concern within the 'scientific management' approach -'invented' by Taylor (1947)- was to improve the productivity of labour. To this end, detailed time, movement and cost studies were made in relation to the tasks and sub-tasks in the production process, and the way their efficiency could be increased by means of specialization, mechanisation, etc. (Taylor, 1947; Gilbreth, 1911, 1919). According to Harrington (1991:55), it is implicitly assumed in present day approaches of scientific management that communication technologies mainly change the way in which management operates and will in principle fit into existing organizational structures when a suitable implementation strategy is adopted. The major function of communication technologies in this view is to control and prescribe the tasks to be performed in an organization.

The main preoccupation within the 'administrative principles' approach (Fayol, 1949) was not so much the execution of specific tasks, but administrative processes within organizations. Like Weber (1947) Fayol developed a list of administrative principles, in which he stressed the importance of authority, command structures, clear objectives, hierarchical decision-making procedures, etc. Until Simon (1961) presented his ideas on 'bounded rationality', human beings were mainly seen as machine-like decision makers within this approach. But even though it has been recognized since Simon that human beings had other interests than those of the organization, and that the feasibility of rational decision-making processes as proposed by Fayol was limited, the idea that organizations could be run as (now somewhat less predictable) machines, did not fundamentally change.

Within this approach communication technologies are still mainly seen as tools in the hands of managers that can be integrated into administrative and decision-making procedures. In contrast to the scientific management approach, the concern is more with fitting communication technologies into work processes, rather than in using them as a tool to determine these work processes as such.

Second wave

The metaphor related to the second wave is described by Watson (1986) and Harrington (1991) as 'organizations as organisms'. In the different schools that can be clustered under this heading "organizations are seen as complex living entities which do not have machine-like qualities" (Harrington, 1991:57), which shows that they are a reaction against the approaches in the first wave.

Social psychologists like Mayo (1933) stressed the importance of human relations and motivation, as influenced by formal and informal organizational arrangements, for the performance of an organization. Participation of employees in decision-making procedures, and cooperation between management and employees were considered to be important tools for what became known as 'human relations management' (Roethlisberger & Dickson, 1961).

Sociological contributions within this metaphor originate from Parsons' structural functionalism. Parsons (1951) uses several biological analogies and states that human activity systems consist of subsystems that perform certain basic functions (adaptation, pattern maintenance, tension regulation, goal attainment, and integration), between which complex input-output relations exist in order to maintain an equilibrium. Harrington also ranks contingency theories under this metaphor. In these theories (e.g. Mintzberg, 1979), it is assumed that organizations operating in different environments require different organizational structures in order to be successful. In other variants (e.g. Woodward, 1980), it is argued that the characteristics of the technologies used in organizations determine the organizational structures needed to effectively manage them.

In all, there is a tendency in these approaches to see human behaviour as determined by organizational arrangements and structures, of which technologies are an integral part. Related is the perception of organizations as complex but essentially harmonious, integrated wholes of social behaviour. Like other technologies, communication technologies are seen as resources that can be brought into an 'organism', leading to structural changes that influence human behaviour in a functional or dysfunctional manner. Given the harmonious and balanced perception of organizations that prevail within these approaches, it is no surprise that, as Harrington (1991:58) points out, "conclusions [related to communication technologies] seem to be doom-laden, predicting dire consequences if we do not get it right".

A relatively recent approach in information management studies, which is at least affiliated to the 'organizations as organisms' metaphor, has -amongst others on the basis of theories developed by the biologists Maturana and Varela (Maturana & Varela, 1984, 1989; Maturana, 1980)- been developed by Winograd & Flores (1986). This approach, which I label the 'autopoietic systems approach', will be discussed in some detail in the final section of this chapter.

Third wave

The third wave in organization theory is metaphorically labelled as 'organizations as processes'. Like Parsons, authors within this metaphor are influenced by 'open systems theory', and describe human activity systems as engaging in continuous exchanges with their environment. Unlike Parsons, however, the boundaries of systems are considered to be much more vague and structures are not seen as having an important determining influence on behaviour. Instead, organizations are seen as systems of interaction between individuals, without a definite form or hierarchy, that mainly exist because -as Harrington (1991:59) describes it- "people are told it does by management teams, corporate identity and so on".

The processes and practices taking place in an organization are seen as shaping and changing organizational structures. Within this wave, different perceptions exist on the nature of the processes that are most relevant in this respect. Cohen et al. (1972) stress the importance of decision-making processes, while others emphasize the importance of political processes in shaping organizational structure (Pettigrew, 1973).

Communication technologies are no longer seen as resources to control and monitor organizational activities and structures, nor as artefacts that themselves have structural properties that determine human behaviour in a predictable manner. Instead, technologies are seen as becoming part of organizations through the interactions and perceptions of and between individuals, and thus their impact is far less predictable.

Various contemporary authors are inspired by and/or build upon the ideas developed in the third wave. This holds, for example, for authors within the soft and critical systems tradition (Checkland, 1981; Churchman, 1979; Ackoff, 1974; Jackson, 1985; Ulrich, 1988, 1983), and for others that label themselves as 'critical' as well (see e.g. Boland & Hirschheim, 1987; Stamper, 1987, 1990a). Time will tell whether the 'critical' approaches may some day be labelled as the fourth wave of organization theory. Before elaborating more on these recent developments I will raise some issues in relation to the mainstream of organization theory that I have briefly discussed.

Paradigms of information

An important theme to discuss in relation to my subject is the way in which data, information and knowledge are conceptualized within the different waves. In relation to this, Harrington distinguishes between two paradigms of information (1991:17).

In the 'resource-driven paradigm', information is seen as a resource and/or a commodity. It is assumed that: (a) information exists independent from its receiver and has a consistent value or meaning, and (b) information does not legitimately change during transmission (Harrington, 1991:17-18). Clearly, this mechanistic perception of information -which is very similar to the one adopted in computer science- fits smoothly with perceptions adhered to in the first wave. In the 'perceptual paradigm' it is assumed that: (a) information does not exist beyond the perception of the individual receiver, and it can therefore not be treated as a resource; (b) communication technologies themselves can only produce data since information is more than processed data; (c) it is data, not information, which is absolute; and (d) information can never be transmitted (Harrington, 1991:20-23). This conceptualization seems more in line with modes of thinking in the third wave.

In practice, one can find several seemingly contradictory definitions of information that apparently originate from a mixture of the two paradigms. A beautiful example is the widely used definition by Davis & Olson (1985:200) "Information is data that has been processed into a form that is meaningful to the recipient and is of real or perceived value in current or prospective actions or decisions". The first part of the definition implies that information can indeed be processed out of data by communication technologies, while the second adds that the form into which the information is processed needs to be meaningful and of real or perceived value for the recipient. Although a subjective definition of information seems to be assumed in the latter part, it is suggested in the first that it is the technology that does the processing.

From a sociological perspective, both paradigms described by Harrington, as well as attempts to mix them, are problematic. My doubts in relation to the 'resource-driven paradigm' have already been discussed in the section 3.1, where I argued that the meaning of information has subjective and contextual connotations.

Within information systems research itself this paradigm has also been challenged on similar grounds by, for example, Stamper & Kolkman (1991) and especially Boland (1987)[4]. The latter identifies "five fantasies of information" that have emerged on the basis of Simon's (1961, 1977) notion of organizations as 'decision-making machines'. In contrast to Simon, Boland (1987) stresses the importance of dialogue in the creation of meaning. It is especially this interactional character of meaning (and thus of information) that leads me to criticize the 'perceptual paradigm'. Within the 'perceptual paradigm' information is seen as "the product of individual perception" (Harrington, 1991:17). Apparently, it is assumed that the interpretations that individuals within an organization have of certain 'data' or phenomena are independent from each other. This is in fact a rather paradoxical assumption for those who study processes in collectivities (such as organizations), even more so where many scholars conclude that an important management task is to *influence* people's perceptions.

Sociological literature suggests that people's interpretations are both contextual and shaped by previous interactions (Schutz & Luckmann, 1974; Gadamer, 1975). Although this is recognized by some (e.g. Winograd & Flores, 1986) I have the feeling that -in general- it is insufficiently acknowledged that people's interpretations are not only contextual and historical, but also linked to strategies and interests that they have vis-à-vis others. That is, both the 'perceptual paradigm' and various other critical conceptualizations of information tend to explore the *subjective* rather than the *social* dimensions of information, and therefore fail to meet the criteria formulated at the end of chapter 2. In relation to this, the usefulness of taking the *individual* as the unit of analysis can be questioned; in section 5.1, I will come back to this and elaborate on an approach in which the notion of 'individual' is replaced by the notion of *social actor*.

If one follows this line of reasoning it becomes unacceptable to see data (seen as input in communication technologies) as absolute facts, as is suggested in the 'perceptual paradigm' of information (see also Jorna, 1992a). In fact, the distinction between data and information is quite useless, since it is a *crucial* and inherent characteristic of communication technologies that the 'data' (input) did have a meaning, at least for the one who put them in. Thus, data are far from neutral, absolute or objective. Outside the context of communication technologies the concept of data is rather obsolete as well. As soon as human beings become *aware* of certain triggers, stimuli or 'data', they have already assigned meaning to them.

In information systems research the dominant conceptualization of knowledge seems rather similar to the one adhered to in computer science, and is therefore equally problematic. At a later stage (see chapter 4) I will argue that the adoption of a 'social paradigm' in relation to both knowledge and information renders the distinction between knowledge and information largely obsolete as well.

Paradigms of structure

An area of great concern in information systems research is the interaction between 'organizational structure' and communication technologies. In the discussion of the three waves in organization theory, I have already illustrated the ways in which communication technologies are perceived to fit in 'organizational structures'. However, I have not paid much attention to the definition of 'structure' itself.

Harrington (1991:49) loosely speaks of a set of 'linkages' within an organization, and adds that "the structure of an organization is seen as providing the framework which turns a collection of people and resources into an identifiable form" (1991:63). According to Harrington, the way in which organizations and their structures (as well as technologies) are perceived ranges from a rather 'physical' view in the first wave, to a 'perceptual' view in the third wave, and he proposes that we need to clarify the interrelations between the physical and the perceptual dimension (1991:61-63). However, my wish to adopt a 'social paradigm' of information and knowledge implies that the physical/perceptional distinction becomes somewhat blurred, because physical phenomena are considered to have social and perceptual dimensions. I will come back to the debate on the relation between the 'material' and the 'perceptual' world in sections 4.2 and 5.3.

At this point I would like to reformulate partly the physical/perceptual distinction, and add a dimension that seems to be overlooked by Harrington. In my view crucial differences exist between the different waves of organization theory, relating to the extent to which physical and/or social structures are seen as determining social action (see also Lyytinen (1987:19) who provides a classification of organizational theories along a determinism/voluntarism dimension). In the first and second wave, structures are basically seen as having an autonomous existence outside social interaction, and as determining -to a large extent- the outcome of such interaction. In the third wave, much more emphasis is placed on the capacities of actors to influence and change organizational structures since such structures are essentially seen as existing in the minds of people. Although Harrington proposes that individual behaviour and organizational structure are closely interrelated (1991:102), he does not seem to solve successfully this theoretical problem, since he argues that:

> "The structure, as it were, steps beyond our direct means of control. Individuals *per se* are merely elements within the structure. They come and go, bring in different qualities and abilities but the structure on the whole, with a few exceptions, continues unchanged. (...) We are nothing more than transmitters and receivers of information; how we act and the roles that we play are a consequence of that. Structure and the individual are so entangled, therefore, that it is impractical to attempt to separate them." (1991:106).

In my view, this conceptualisation of the relation between structure and the individual places Harrington right back in the first or second wave of organization theory. His solution is essentially deterministic, and fails to meet the requirement that an adequate theoretical framework for understanding the use and development of communication technologies must include an *active* conceptualization of human action (see section 2.3). What is needed to transcend the different positions taken is a fundamental (meta-)theory of what exactly social structures are, how they influence social (inter)action and vice versa. Similarly, if we accept that social structure has a perceptual dimension, we must explore the interrelations between knowledge and structure. In section 3.3 I will briefly come back to these issues when discussing the autopoietic systems approach, and in chapter 5 I will arrive at more definite conclusions in this respect.

3.3 Systems approaches

In this section I will discuss some approaches which cannot be easily ranked under the mainstream schools of thought in informatics or information management studies. This is mainly due to the fact that the authors who advocate them -even if many of them originate from management science or computer science- have explicitly incorporated fundamental philosophical, biological and/or sociological insights in their respective approaches. In the context of this study, a discussion of the hard, soft and critical modes of systems thinking is especially relevant for uncovering different conceptualizations of rationality, whereas a discussion of the autopoietic systems approach is important for exploring alternative conceptualizations of knowledge, structure and the interrelations between the two.

Paradigms of rationality: hard, soft and critical systems approaches

The hard, soft and critical systems modes of thinking about organizations, organizational change and decision making are connected with the different approaches in organizational theory that I have introduced earlier on. The reason to discuss them separately is mainly pragmatic and related to the fact that a coherent and very popular body of literature exists, written by a clearly identifiable network of authors. Thus, it would -even if possible[5]- be somewhat artificial to try to fit them in a different classification of organization theories. I will briefly discuss hard and soft systems approaches in order to introduce the critical systems approach, and place it in a historical perspective.

'Hard' systems thinking
In 'hard' systems thinking, social systems are assumed to be goal-seeking systems (Checkland 1985:759). In this view organizations are primarily seen as systems that can and should be engineered and optimized in a rational manner towards a previously defined goal. Although influential writers in this management tradition (e.g. Simon, 1961, 1977) considerably shade the scope for 'optimal' solutions and rationality, they maintain -as Checkland (1985:759) points out- "that problem solving is a search for an end we already know to be desirable". Ulrich (1983, 1988) argues therefore that the conception of rationality used in this approach is utilitarian, and can be traced back to Weber's 'ideal types' of

rational action ('value rationality' or Wertrationalität and 'purposive rationality' or Zweckrationalität) which together form a subjective means-end type of rationality (Ulrich, 1988:142). In Habermas' terms (1981), we can speak of instrumental rationality since those adopting it essentially see other social actors merely as objects or things that can be manipulated to achieve certain ends. The rational allocation of scarce resources with the help of e.g. cost/benefit analysis, linear programming models, problem decomposition, and models of rational choice, has become a major area of concern in this tradition. In information systems research this concern was reflected in a growing popularity of operational research techniques, systems analysis (e.g. Quade & Boucher, 1968) and systems engineering (e.g. Jenkins, 1969) methods (see also Ulrich, 1988; Checkland, 1978).

'Soft', 'interpretative' or 'appreciative' systems thinking

The 'hard' systems approach has been severely criticized by 'soft' systems thinkers (Vickers, 1983; Checkland, 1981; Ackoff, 1974; Churchman, 1979). In their view 'human activity systems' such as organizations must be looked at as complex wholes, in which people have different world views or *Weltanschauungen* (Checkland & Davies, 1986) and therefore have different interpretations of the problems that exist, the goals to be achieved in relation to these, and the boundaries of the system itself. In order to manage this complexity soft systems thinkers have developed methodologies (Checkland, 1981; Ackoff, 1981) aimed at reaching agreement and consensus on problems, ends and boundaries. For example in Checkland's (1981) Soft Systems Methodology, it is assumed that stakeholders in a particular problematic context (including experts, consultants, etc.) can develop a new 'systemic' shared perception (or model of reality) that can be compared with the original models that the different stakeholders had. Thereby the comparison of different interpretative models provides:

> " ... the structure of a dialectical debate, a debate which will change perceptions of the problem situation, suggest new ideas for relevant systems (leading to iteration), and concentrate thought on possible changes" (Checkland, 1988:28).

> "The aim of the debate is to find some possible changes which meet two criteria: systemically desirable <u>and</u> culturally feasible in the particular situation in question" (Checkland, 1985:764).

The emergence of similar approaches within the domain of information systems research meant that the focus shifted from problem decomposition and control to problem identification and understanding (Ulrich, 1988:153). As Ulrich points out, this shift went along with a growing interest in simulation techniques (Forrester, 1971), cybernetic modelling (Ashby, 1956; Beer, 1985), game theory (Von Neumann & Morgenstern, 1953; Rapoport, 1960), and portfolio management (Markowitz, 1959). The soft systems approaches have also inspired more recent attempts to model organizations with the help of artificial intelligence techniques and semantic analysis (Stamper, 1987, 1988, 1990b; Stamper & Kolkman, 1991).

'Critical' systems thinking

Implicit to the soft systems approach is the rather optimistic and naive assumption that the 'collective learning process' takes place in a very open and eventually harmonic atmosphere. Ulrich (1988) and especially Jackson (1985) have criticized the soft systems approaches for not recognizing that the conditions for such an open debate aimed at reaching true consensus are often lacking. According to Jackson (1985:145), "power structures" can considerably affect such a debate, and result in situations in which stakeholders have no equal say in discussion, and no equal access to relevant material and resources. Consequently, the application of soft systems methodologies can easily lead to a reinforcement of the status quo; as Jackson (1985:144) puts it:

> "... soft systems thinking cannot pose a real threat to the social structures which support the Weltanschauung with which it works. It can tinker at the ideological level but it is likely simply to ensure the continued survival by adaptation, of existing social elites (Thomas & Lockett, 1979; Jackson, 1982). This is not at all what the designers of the soft systems methodologies intended. Nevertheless, there is some evidence that it is what is achieved by these approaches. Churchman, Ackoff and Checkland are baffled that their methodologies when applied to the real world tend to lead to conservative or, at best, reformist recommendations for change. Examples of such bafflement can be found in Churchman, 1971:228; Ackoff, 1979; and Checkland, 1981:15."

To the extent that soft systems approaches have characteristics that encourage their use by managers (or for that matter facilitators) as a tool to deal with and overcome complexity and uncertainty (Ulrich, 1988), I would -unlike Ulrich (1988:154, footnote 11)- maintain that their underlying rationale is still utilitarian. Thus, even if in Habermasian terms the soft systems approaches are -in their application- often still characterized by cognitive-instrumental rationality, it is clear that the type of action associated with such application differs from that in the 'hard' systems approach in the sense that it involves strategic rather than instrumental action. That is, the manager or facilitator perceives the other stakeholders not as mere objects, but as other strategic actors, with whom conflicts are to be settled in a rational manner. In this negotiation process, however, the aim of the manager (and other stakeholders) is still to maximize their own interests.

In order to overcome the shortcomings of the soft systems approaches many critical systems thinkers turn to the works of Habermas (e.g. Jackson, 1985; Ulrich, 1988; Fuenmayor & López-Garay, 1991; Lyytinen & Klein, 1985). Habermas (1981:384) adds a third type of action to the instrumental and strategic action discussed earlier on: communicative action, which simultaneously involves communicative rationality. Starting from critical theory and discourse theory, Habermas develops the notion of an "ideal speech situation" in which undistorted communication can take place (Habermas, 1970a, 1970b, 1981, see also chapter 5). In such a situation, conflicts of interest are solved by the "peculiarly unforced force of the better argument" (Habermas, 1973:240).

In an ideal speech situation the participants are able and willing to take other people's interests into account, and scrutinize their own and other actor's validity claims which their speech acts inherently imply. Thus, consensus on the definition of the situation and the resulting strategies to be adopted are based on *arguments*, rather than on a strategic compromise. Decisions made in this fashion are considered to be rational in a communicative manner which does not mean that the arguments underlying the decision are based on 'objective' knowledge in the positivistic sense, but that they are based on consensus about what is true, valid, relevant, etc., or not.

According to Ulrich (1988:140-143), communicative rationality, therefore, has a normative rather than an empirical validity, and has to be considered as social rationality rather than subjective (or utilitarian) rationality.
In the 'critically normative systems approach' proposed by Ulrich (1983, 1988) the focus is on the "management of conflict by means of argumentatively secured mutual understanding" (1988:153). According to Jackson (1982:25), systems methodologies should provide conditions for undistorted communication. Moreover, they should contribute to the fulfilment of three functions that Habermas identifies when discussing the relationship between theory and practice (Jackson, 1985:146; Habermas, 1973): (1) the provision of critical social theories; (2) the organization of enlightenment, in order to socially validate the theories; (3) the selection of appropriate strategies. In cases where communicative rationality cannot be secured, social groups may have to discontinue the process of dialogue and enlightenment, and temporarily engage in political struggle (Jackson, 1985:149). Ulrich takes a slightly different point of view and suggests that it is not so much the task of systems methodologies to provide conditions for undistorted communication, but rather to critically deal with conditions of imperfect communicative rationality (Ulrich, 1988:158).

In information systems research, the importance attached to language (Boland, 1987; Lyytinen, 1985, 1987; Winograd & Flores, 1986), semantics (Stamper, 1987, 1990b), and speech act theories (Chen, 1987; Winograd & Flores, 1986) which had already emerged in relation to the development of 'artificial intelligence' techniques, has only increased in the light of critical systems thinking. Language, for Habermas, is the medium of communicational experience and action, and therefore a potentially important medium for structural change (see chapter 5).

Of course, significant questions can be raised with regard to the theoretical possibility and the practical feasibility of Habermas' "ideal speech situations" (see chapter 5). In relation to this we can also question if soft and critical systems thinkers do indeed succeed in abandoning functionalistic notions altogether. Where Parsons (1951) assumes that organizations are integrated wholes that inherently perform certain functions, the soft and critical systems thinkers suggest at least that organizations can realistically become integrated wholes with a fairly unambiguous mission, if only those that manage them adopt certain methodologies and/or provide conditions for undistorted communication. That is, there still seems to be an underlying assumption that human behaviour can be determined by means of externally provided structures, i.e. methodologies and conditions. This means that it is doubtful if this framework allows for an *active* conceptualization of human action (see section 5.2 for a more detailed discussion of a.o. functionalistic connotations in Habermas' work).

Nevertheless, the critical systems approach adds a potentially important dimension to the analysis of the use and development of communication technologies. Unlike most of the approaches discussed earlier in this chapter it seems to imply that -in order to understand CT-mediated interactions- attention must be paid to the specific *contents* (i.e. validity claims) that are built into -and/or communicated through- communication technologies. Similarly, in line with the criteria formulated towards the end of chapter 2, this theoretical framework -by providing a procedural conceptualization of communicative rationality- seems to at least partially recognize the importance of contextual and historical conditions for the explanation of communication processes. A third contribution is that -in contrast to other approaches- the critical systems approach offers several definitions of rationality, whereby explicit attention is paid to the social (normative and political) dimensions of rationality.

The 'autopoietic' systems approach

Finally, I want to discuss the 'autopoietic' systems approach developed by Winograd & Flores, 1986. This approach deserves our special attention since: (a) it is especially developed to understand the use and development of computers; (b) Winograd & Flores too regard computers and computer programs essentially as media for communication; and (c) concepts like structure, rationality, and knowledge are explicitly problematized and discussed (see below).

The labelling of Winograd & Flores' approach as 'the autopoietic systems approach' is my own, but rests on the fact that their work was heavily influenced by the works of Maturana and Varela (Winograd & Flores, 1986:38). Maturana & Varela (1980, 1984, 1989) are biologists who have tried to develop a theory of 'living'. In a critique of traditional biology, they propose that 'living' cannot be defined in terms of components, properties, and/or characteristics of living systems, but should be defined in terms of the relations of (re)production between the components of a system. Maturana & Varela (1989:33-34) propose that living systems are distinct in that they literally reproduce themselves continuously; in other words, they are autopoietically organized (the Greek word 'autos' can be translated with 'self', while 'poiein' means 'to make'). More precisely they define an autopoietic system as:

> "... a network of processes of production (transformation and destruction) of components that produces the components that: (i) through their interactions and transformations continuously regenerate the network of processes (relations) that produced them; and (ii) constitute it (the machine) as a concrete unity in the space in which they (the components) exist by specifying the topological domain of its realization as such a network." (Maturana & Varela, 1980:79 in Winograd & Flores, 1986:44)

An important aspect of Maturana & Varela's conceptualization of autopoietic systems is that in the process of (re)production they only refer to themselves; that is, even though a system may need material inputs from the environment, it is the system itself that determines the changes that take place as a result of the interaction between system and environment (Maturana & Varela, 1989:41). This, implies indeed that Maturana & Varela abandon the idea that living systems adapt to their environment, for the environment exists only to the extent that the system perceives and recognizes it as its environment. Thus, autopoietic systems are organizationally closed systems of production relationships. Nevertheless, system and environment can interact through reciprocal perturbations which may even result in (but not determine or instruct) structural changes in either autopoietic systems or environment (Maturana & Varela, 1989:63,77). In case of recurrent interactions between system and environment Maturana & Varela speak of structural congruence or structural coupling (1989:63,77). In case of structural coupling between different autopoietic systems (e.g. cells in an organism) composite living systems (or second-order autopoietic systems) can develop.

Maturana & Varela claim that their theory of living is also a (biological) theory of cognition; 'living' is seen as a process of cognition and living (autopoietic) systems are therefore essentially cognitive systems:

> "A cognitive system is a system whose organization defines a domain of interactions in which it can act with relevance to the maintenance of itself, and the process of cognition is the actual (inductive) acting or behaving in this domain" (Maturana, 1980:13 in Winograd & Flores, 1986:47).

The implication of this is that cognition too is an autopoietic process; that is, what autopoietic systems (e.g. human beings) 'know' about the environment needs to be understood in terms of their internal constitution, rather than as a representation of external 'facts' (Maturana & Varela, 1989:19). Thus, they propose indeed to see cognition as a (neurophysiological) biological phenomenon. The fact, for example, that a frog can catch a fly is due to the fact that -as a result of structural coupling- the nervous system generates a specific pattern of activity which is triggered by specific perturbations (i.e. small moving dark spots) and not because it carries a *representation* of a fly (Maturana & Varela, 1989:100-101; Winograd & Flores, 1986:46). A cognitive (rather than a mechanistic) explanation of why frogs can catch flies -according to Maturana- centres around the question of which perturbations have led to such mechanistic structure-determined behaviour. Thus, such cognitive explanations are essentially historical in nature:

> "... as a result of the structural coupling that takes place along such a history, history becomes embodied both in the structure of the living system and the structure of the medium even though both systems necessarily, as structure determined systems, always operate in the present through locally determined processes (...) History is necessary to explain how a given system or phenomenon came to be, but it does not participate in the explanation of the operation of the system or phenomenon in the present" (Maturana, 1978:39, as cited by Winograd & Flores, 1986:47).

In their approach Winograd & Flores (1986:27-37, 70-79) connect Maturana & Varela's framework with the hermeneutic approaches developed by Gadamer (1975) and Heidegger (1962), and with speech act theory as generated by Austin (1971), Searle (1969) and Habermas (1981a, 1981b).

Both Gadamer -who elaborates on the historical and contextual nature of interpretation- and Heidegger -who emphasized the fundamental unity of *being-in-the-world* (c.q. Dasein or 'thrownness')- reject some core assumptions which are made in what Winograd & Flores label "the rationalistic tradition" (1986:14-26). That is, they repudiate: (a) the separation between the 'object' and 'subject', i.e. the distinction between an 'objective world' and a 'world of experience', and (b) the idea that human beings are consciously reflecting and logically deducing creatures. Instead it is argued that: (a) the beliefs and assumptions which underlie action cannot all be made explicit; (b) practical understanding is more fundamental than detached theoretical understanding (i.e. in our 'thrownness'[6] we have to rely on cognition as praxis); (c) in order to relate to things it is not necessary to have a representation of them; such representations usually emerge in an event of *breaking down* (i.e. when things can no longer be taken for granted); and (d) meaning is not individual but a social accomplishment (see Winograd & Flores, 1986:32-33, 36-37).

According to Winograd & Flores, Heidegger and Maturana thus arrive -be it through different ways of reasoning- at similar conclusions with regard to their conceptualization of knowledge in that "both oppose the assumption that cognition is based on the manipulation of mental models or representations of the world" (1986:73). While Maturana argues that -even in the case of much more complex activities than frogs catching flies- it is misplaced to in any way claim that representations are present in the nervous system, Heidegger claims that -apart from situations of breaking down- knowledge lies in 'being-in-the-world' and not in reflective representations.

In their theory of language, Winograd & Flores draw upon both speech act theory and the hermeneutic conceptualizations of Maturana, Heidegger and Gadamer. They assert that in day-to-day practice it is misleading to regard language expressions as having a literal meaning; instead language (like cognition) is inherently social in nature, whereby they mean that "our ability to think and give meaning is rooted in our participation in a society and a tradition" (1986:61). Furthermore, they take over the view adopted in speech act theory (see Austin, 1971; Searle, 1969; Habermas, 1981a, 1981b) that 'to speak' is 'to act'; a language utterance is not just a representation of something, but includes a particular commitment and/or purpose and is therefore to be regarded as an *action*. Thus, meaning arises from listening to such commitments expressed in speech acts. Finally, they describe regularities in the use of language as an expression of structural coupling (as conceptualized by Maturana), and they connect such 'recurrent structures of conversation' with recurrent patterns of breakdown (as conceptualized by Heidegger). On the basis of all this they conclude that "nothing exists except through language".

Although I feel sympathetic towards the way in which Winograd & Flores conceptualize rationality and criticise 'the rationalistic tradition', I am far less happy with the theory of structure and knowledge that characterizes the autopoietic systems approach. Even if Winograd & Flores do not explicitly propose to treat *social systems* as autopoietic systems -as for example Luhmann (1982) has done (see also section 7.5)- they do indeed treat individual human beings as such. Thereby, they analyze the interrelations among human beings in terms of the structural congruence between autopoietic systems and environment. In the context of the criteria formulated towards the end of chapter 2, it is certainly an improvement that, from an autopoietic perspective, social action cannot be seen as being externally determined. However, by treating social actors as *internal* structure-determined systems the approach can still be characterized as deterministic. What is lacking in this conceptualization of action and structure is a notion of human agency, i.e. the idea that human beings can influence their structural environment in ways which are not purely accidental, but include a certain amount of intention and strategy. The same omission can be found in the biological conceptualization of cognition; essentially this conceptualization denies that actors can creatively and strategically generate and put forward interpretations and/or representations.

Despite these theoretical omissions, the autopoietic systems approach generates a number of interesting theoretical ideas and issues that must be somehow incorporated or dealt with in my eventual theoretical framework, such as: (a) the importance of history in the formation of structure; (b) the recursive nature of structure and the importance of recurrent practices therein; (c) the historical and contextual nature of meaning; (d) the importance of practical understanding and 'thrownness'; (e) the connection between reflection and 'breaking down' or discontinuity; and (f) the 'blindness' that is associated with the rationalistic approach (Winograd & Flores, 1986:17).

Moreover, Winograd & Flores have on the basis of this theory developed a number of intriguing ideas in relation to management and the nature, use and design of computer applications (i.e. communication technologies):

> "Our central claim in this book is that the current theoretical discourse about computers is based on a misinterpretation of the nature of human cognition and language. Computers designed on the basis of this misconception provide only impoverished possibilities for modelling and enlarging the scope of human understanding. They are restricted to representing knowledge as the acquisition and manipulation of facts, and communication as the transferring of information. As a result we are now witnessing a major breakdown in the design of computer technology - a breakdown that reveals the rationalistically oriented background of discourse in which our current understanding is embedded.
>
> The question we now have to deal with is how to design computers on the basis of the new discourse about language and thought that we have been elaborating. Computers are not only designed in language but are themselves equipment for language. They will not just reflect our understanding of language, but will at the same time create new possibilities for the speaking and listening that we do - for creating ourselves in language" (Winograd & Flores, 1986:78-79).

In relation to the 'design question' they propose amongst others:

(a) that the "most successful designs are not those that try to fully model the domain in which they operate, but those that are 'in alignment' with the fundamental structure of that domain, and that allow for modification and evolution to generate new structural coupling" (Winograd & Flores, 1986:53);

(b) that "the designer of a computer tool must work in the domain generated by the space of potential breakdowns" (Winograd & Flores, 1986:72). It is important for designers to *anticipate* these breakdowns, and be aware of the blindness that is unavoidably created within computer programs (Winograd & Flores, 1986:164-167);

(c) that designers should be aware of the fact that -although they can have unintended consequences (Winograd & Flores, 1986:90-92)- computers cannot be intelligent, since: (a) human intelligence (following Heidegger) is in our thrownness, and not in reflection (Winograd & Flores, 1986:99), and (b) because computers themselves can never enter into a commitment (while human beings can), whereas the theoretical framework points out "the centrality of commitment for those aspects of intelligent behaviour that initially seem based on more objective ideals of rationality" (Winograd & Flores, 1986:106). It is through these two characteristics that human intelligence and blindness differ fundamentally from the 'intelligence' and 'blindness' of computer applications. In fact, the differences between computers and mechanical devices (like a clock) are only gradual, and are to be found primarily in the context in which they function (Winograd & Flores, 1986:93-95);

(d) that designers should recognize that managers are not so much involved with 'decision making', but rather with the generation and maintenance of a network of conversations for action (Winograd & Flores, 1986:144). Obviously this has repercussions for the nature of systems that are supposed to support 'management'. In fact, Winograd & Flores (1986:157-162), promote the idea of 'coordination systems' which play a role in networks of recurrent conversations.

I will come back to the relevance of these points for the domain of agro-informatics while summarizing the practical contributions that were arrived at in this book in chapter 11.

Notes

1. A 'calculation' in this sense can be seen as a sequence of unambiguous steps that are to be performed in order to reach a solution to a particular problem. A calculation that leads to an answer for all possible input values is called an algorithm.

2. Here we already touch upon very fundamental discussion concerning the boundaries of organizations, systems, networks, etc., which I will discuss in more detail later on.

3. Lyytinen (1987) has -using different dimensions- also developed a detailed classification of approaches in organization theory which he connects explicitly with different roles attributed to communication technology.

4. Stamper & Kolkman (1991:70) state that: "there is no reality without an agent, and the agent constructs his knowledge of reality through his actions." The latter part of this statement implies, amongst others, that knowledge does not necessarily precede action, at least not in the sense as is suggested by Simon (1961, 1977). Boland (1987:372) points out that the misconception that knowledge precedes action underlies the fantasy that 'an organization is information', and he refers to Schutz (1967) who has "argued persuasively for the priority of action and the retrospective nature of almost all understanding of action as purpose". Other 'fantasies' that Boland criticizes are that 'information is structured data', 'information is power', 'information is intelligence' and that 'information is perfectible'.

5. The hard systems approaches can be quite smoothly classified in the first and second wave of organization theory. Writers within the soft systems tradition make clear that they want to avoid the functionalism of the second wave, and can therefore be provisionally ranked as belonging to the third wave. The critical systems approaches criticize the soft systems approaches for their lack of attention for political issues, and advocate a more radical break away from functionalism than achieved by soft systems thinkers.

6. In order to clarify the concept of 'thrownness' Winograd & Flores (1986:33-36) identify a number of characteristics of situations which actors have to frequently confront: (a) one cannot avoid acting; (b) one cannot step back and reflect on one's actions; (c) the effects of actions cannot be predicted; (d) one does not have a stable representation of a situation; (e) every representation is an interpretation; and (f) language is action.

Chapter 4

Current contributions from communication science: computer mediated communications in organizations and extension science

4.1 Communication science and computer mediated communications in organizations

In communication science a more or less distinct body of literature exists on computer mediated communications in organizations. The focus on computers as media for communication in this field of study fits neatly with my conceptualization of such technologies as 'communication technologies'. Therefore, we can expect to find some useful insights from communication science.

Many studies in this branch of communication science seek to explain and predict (non) adoption and impact of new communication technologies in organizations. Naturally, different approaches exist with regard to the way in which such change and adoption processes are perceived and explained. It will come as no surprise that these are intertwined with the different 'waves' in organization theory that were discussed in chapter 3. In this section I will use a classification suggested by Steinfield (pers. comm. 1991) for categorizing the schools of thought in the field of computer mediated communications (CMC), and speak of contingency (or media-centred) approaches, critical mass (or social context) approaches and social influence models[1].

Contingency approaches or media-centred approaches

The basic assumption underlying contingency approaches is that the choice for, and/or the effectiveness of, a certain medium (in this case communication technology) can be explained by the extent to which the *characteristics of the communication technology* match the *characteristics of the tasks* that it needs to perform. Some CMC-authors of this inclination share the conceptualizations of information, communication, structure and rationality that I have identified within the first wave of organization theory and the hard systems approach. Beniger (1986, 1990), for example, stresses that communication technologies are necessary in order to combat the crisis of *control* that has emerged as a result of industrialization. Depending on the *characteristics of the control problem*, a suitable technology needs to be adopted. His 'organizations as machines' perspective can best be illustrated with the following quotes:

"In short, formal organization might be seen as the best known means to make a computer before the development of electronics" (1990:32).

"Like brains and computers, organizations are *controllers*, that is, they exist primarily to process information -and thereby at least partially to control external factors- towards some predetermined set of goals (which of course might be modified as this process unfolds). To the extent that all controllers are homologous with respect to information processing, decision, and control, understanding of either formal organization, the human brain or computers and related information technologies might be informed by theory involving information usually associated with any of the others" (1990:43).

A similar abstraction from the contextual, subjective and social aspects of information, communication, goal definition and rationality, can be found in Huber (1990) and Nass & Mason (1990) with respect to the conceptualization of structure. In advocating a 'variable-based' approach to the study of technology and task, the latter explicitly fall back on the scientific management tradition that emerged on the basis of Taylor's (1947) work (Nass & Mason, 1990:50). Following Taylor, and in contrast to the context sensitive case-study approaches that are often applied in the CMC field[2], Nass & Mason identify *characteristics* of communication technologies and organizations that can be operationalized into variables. These variables must meet certain criteria, one of which is that they can function as dependent, independent or intervening variables[3]. Depending on the design of the research, then, the researchers are expected to be able to:

"... make conclusions that will apply to a wide range of technologies (and organizations), including technologies (and organizations) that the researcher has never seen and including technologies (and organizations) that do not even exist yet" (1990:62).

Although Huber (1990) may, from the viewpoint of Nass & Mason, generalize too much about 'the' characteristics of what he calls 'advanced information technologies'[4], he does indeed develop a large number of general statements about their effects on organizational design, intelligence and decision making. Thus, as in the first wave of organization theory and hard systems thinking, specific social contexts and human agency do not play a significant role in the approaches developed by Nass & Mason and Huber. Human behaviour is seen as determined by structural properties of technologies and/or organizations.

Others (e.g. Zmud, 1990; Trevino et al., 1990) share perceptions of information, communication, structure and rationality that are more akin to those in the second wave of organization theory and soft systems thinking.

Trevino et al. (1990) start from a symbolic interactionist framework and classify different communication technologies on a 'media richness' continuum. The media richness of a medium (or communication technology):

"is based upon a blend of four criteria: (1) the availability of *instant feedback*, making it possible to converge quickly upon a common interpretation or understanding; (2) the capacity of the medium to transmit *multiple cues* such as body language, voice tone, and inflection to convey interpretations; (3) the use of *natural language*, rather than numbers, to convey subtleties; and (4) the *personal focus* of the medium. A message will be conveyed more fully when personal feelings

> and emotions infuse the communication. Some media allow the message to be tailored to the frame of reference, needs, and current situation of the receiver" (1990:75).

On the basis of these criteria and empirical studies, they rank media along a continuum in order of decreasing 'medium richness': face to face, telephone, electronic mail, letter, note, memo, special report, flier/bulletin. Computer applications that are frequently used in the context of agro-informatics (e.g. expert systems, simulation models, databases, etc.), and that I have labelled 'communication technologies' as well, are excluded from this list.

The major concern of Trevino et al. (1990) is both to explain and prescribe effective managerial media choice and practice. They identify 'message equivocality' as an important determinant of media choice. Equivocality is high when messages are ambiguous, and/or when the frames of reference of the communicators differ (Trevino et al., 1990:74). Trevino et al.'s main point, then, is that the more equivocal a message is, the greater the information richness of the medium chosen will (need to) be.

At first sight Trevino et al. seem to be more 'context sensitive' than Nass & Mason, since they recognize that contextual aspects and symbolic meanings may result in 'non-optimal' media choices. However, they speak of contextual aspects in terms of 'contextual *determinants*' (such as distance, time pressure, accessibility and critical mass of users) and present these as forces that are somehow external to the agents involved[5]. Also, they recognize the existence of "symbolic cues conveyed by the medium itself above and beyond the literal message" (1990:74). That is, depending on the organization's culture, the use of specific media may have certain symbolic meanings. Thus, although Trevino et al. adopt a more interpretative and subjective definition of information, they tend to exclude the social and political dimensions of information and assume that the equivocality of messages can be 'objectively' determined in advance. In line with for example soft systems thinkers, they tend to portray organizations as rather harmonious entities in which actors try to overcome (rather than create) ambiguity, and bridge (rather than maintain) differences in frames of reference:

> "However, organization members look to each other for help in interpreting ill-defined situations. In ill-defined situations, they must create a common understanding (Weick, 1979; Daft & Weick, 1984) before they can make decisions that others will comprehend, agree upon, and accept. In this type of situation, organization members proactively shape reality together. Through negotiation and feedback they decrease ambiguity and create symbols that establish new organizational meanings" (1990:73).

To a limited extent, the social dimension of information seems to be implicit in Zmud's (1990) discussion of what he calls 'strategic information manipulation' in organizations (i.e. deliberate attempts of actors within an organization to 'misrepresent' information to others, see also Pettigrew, 1973). Zmud describes an organization's information system (whether automated or not) in a rather functionalist manner as consisting of interconnected networks of processing nodes (sensor nodes, filter nodes, router nodes, carrier nodes, interpreter nodes, learner nodes and modifier nodes) and information buffers (Zmud, 1990:97ff), and proposes that the structural *characteristics* of present-day communication technologies will affect the functioning of these 'modules' in such a way that "the incidence of strategic information behaviours will increase" (1990:111).

While Zmud's perception of structure is again clearly functionalist, his conceptualization of information is more paradoxical[6]. On the one hand the very notion of '*strategic* information manipulation' seems to suggest a recognition of the inherent socio-political aspects of meaning and information, and Zmud does indeed describe the phenomenon as a "natural" and "integral aspect of organizational life" (1990:114). On the other hand, Zmud seems to hold on to the mechanistic notion that information does not legitimately change in communication processes, since he describes misrepresentation as a "threat" (1990:107). In fact, the very term '*mis*'representation suggests that there somehow is a normal, correct, non-subjective and non-strategic interpretation or representation of information. Misrepresentation, then, is a regrettable exception, while -as I have argued earlier on- differences in interpretation and/or representation of the same 'data' must be seen as an inherent characteristic of communication. Furthermore, Zmud rejects Daft & Weick's (1984) claim that sensing, interpreting and learning are the most critical information processes in organizations, and suggests that filtering, routing and modifying are dominant processes that precede the interpretative processes mentioned by Daft & Weick (1990:106). Thus, routing, filtering and modifying are seen as mechanical processes that can be fundamentally distinguished from the processes mentioned by Daft & Weick.

Critical mass approaches or social context approaches

Another 'mainstream' branch within CMC studies seeks to explain the use or non-use of communication technologies from their social context. The concept of 'critical mass' is central to many of these studies (e.g. Rohlfs, 1974; Uhlig et al., 1979; Rogers, 1986; Markus, 1990). A major concern in critical mass approaches is the spread or 'diffusion' of communication technologies within (segments of) society. It is argued by Markus (1990) that the diffusion of communication technologies (and especially so-called interactive media[7]) differs from those of other innovations in two ways. First, whereas it is generally assumed for 'ordinary' innovations that later adopters are influenced by positive and/or negative experiences of earlier adopters, this is not the case in the context of communication technologies for decisions of early adopters may be influenced by later adopters: if the technology does not become widely used, early adopters may discontinue their use of it (Markus, 1990:197ff). Thus, Markus argues that the interdependence of individual decisions is *reciprocal* rather than *sequential*.

Diffusion of innovation approaches have been severely criticized for their unilinear simplicity and abstraction from social and political issues. An element of these criticisms is that the concept of 'sequential' interdependence is not very appropriate, even for ordinary technologies. Related to the highly competitive nature of Dutch agriculture, for example, is the fact that some categories of farmers adopt technologies precisely because they anticipate that others will not, or only later, (be able to) adopt them (Roep et al., 1991; Leeuwis & Arkesteyn, 1991). The term 'reciprocal' interdependence is not very fortunate either, because it suggests that adoption only depends on the decisions and attitudes of other potential adopters (e.g. farmers), whereas in fact many studies have shown (e.g. Röling, 1988) that the appropriateness of technologies in the wider institutional context is an important explanatory factor. This implies that many different actors (such as suppliers of inputs, traders, etc.) have to 'reciprocate' the decisions of farmers. Thus, the term 'social' interdependence, or 'network' interdependence would be more appropriate than 'reciprocal' interdependence.

In contrast to the first, Markus' second peculiarity concerning the diffusion of communication technologies seems to acknowledge some political dimensions of adoption processes. It is argued that "universal access to interactive media comprises a public good, or collective benefit, that cannot be denied to people who have not worked to achieve it" (Markus, 1990:214). Drawing upon Oliver et al. (1985), Markus argues that communication technologies have an accelerating, rather than decelerating, 'production function', which means that later adopters have a progressively higher return to their investments than earlier ones, rather than the other way around (1990:201ff). This makes it difficult to achieve universal access to (and use of) communication technologies, because the investments of early adopters are disproportionately high; however, once the initial investments have been made, universal access can be established rapidly[8]. Hence, especially for technologies with an accelerating production function, a certain amount of heterogeneity in interests and resources among members of a community was found to be beneficial for the development of universal access. In relation to this, a critical mass is defined by Oliver et al. (1985:524) as "a small segment of the population that chooses to make big contributions to the collective action while the majority does little or nothing."

The contextual character of these approaches is situated in the fact that, as Markus (1990:208) puts it, the community is the unit of analysis, rather than the individual. In doing so, these approaches go further than contingency approaches in that they take as a starting point that the behaviour of individuals is interdependent with that of others. However, this does not prevent Markus from making general propositions across communities in a functionalistic and reified fashion. Again, little explanatory power is attributed to the particularities, processes and agents that characterize these contexts; once certain conditions are present or have been fulfilled, the likelihood of certain social outcomes (i.e. universal access) is increased. Furthermore, the critical mass approach pays no attention to content (i.e. the information that is supposed to be communicated through the media in the first place), let alone its social nature, as an explanatory element for understanding the use of communication technologies.

Social influence models

In contrast to critical mass approaches, social influence models -that show similarities to third wave approaches in organization theory- emphasize the importance of specific contexts in explaining the use of communication technologies.

Fulk et al. (1990), for example, criticize the technological determinism and the rationalist bias that is present in many contingency approaches, and particularly those within information richness theory (Trevino et al., 1990) and social presence theory (Short et al., 1976)[9]. They (1990:120) point to the considerable evidence that contradicts the hypotheses made in contingency approaches. Since contingency adepts refer to empirical evidence as well, this implies that the specific social context may indeed play an important role. Therefore, Fulk et al. (1990:119ff) reject the assumptions underlying contingency approaches that media and tasks have inherent characteristics that are: (a) salient to users, and (b) invariant from the context in which they emerge. Also, the validity of the underlying assumption that people take media decisions independently from others, and that choice making is an objectively rational, cognitive, prospective and efficiency motivated process is seriously questioned. Instead, they assert that media and task characteristics are variable, partly socially constructed (that is, subject to social influence) and therefore variably salient in different social contexts. Although they maintain that choice making is a cognitive process, they recognize that it is an interdependent, subjectively- and possibly retrospectively-rational process, that may or may not be efficiency-motivated (1990:121ff).

In Fulk et al.'s model (1990:128), individual media use is treated as an independent variable, on which four types of social influence can have a direct and/or indirect effect: (1) direct statements by co-workers about media and task characteristics; (2) vicarious learning from observing other people's experiences; (3) social norms related to the use of media; and (4) (normatively based) definitions of rationality. Apart from these social influences, individual media use, according to Fulk et al., is also affected by objective media and task features, media and task experiences and skills, and situational factors. In this approach social outcomes are treated as far less predictable and individuals are indeed on their way to becoming active and historically situated social actors, whose conduct is not effectively determined by external structures. However, although Fulk et al. add considerably to contingency and critical mass approaches, four problems remain:

(1) It does not appear from their model how overt statements of co-workers, other peoples experiences, social norms, etc., come about, and how they acquire legitimacy; that is, why do certain people's media perspectives come to be accepted and others not. In other words, their approach lacks a communication theory that makes clear how meanings are established (see also Contractor & Eisenberg, 1990:147), which is for example reflected in the fact that power issues are not explicitly dealt with.

(2) Like the other approaches discussed in this section, the specific content of what is being communicated still has no explanatory power for media use, other than in terms of 'message equivocality' or other task evaluations.

(3) It is implicitly assumed that social influence does not impinge on 'objective' media and task features, experience and skill, and situational factors, whereas it could be argued that these have also emerged through social processes in time and space; neither communication technologies, previous experiences and situational factors arise out of the blue; that is, they can be shaped by social influence as well.

(4) Last but not least, Fulk et al. use a very linear type of causality[10], and thereby disregard the ways in which media use simultaneously affects task evaluations, media and task features, situational factors and social interactions (see also Contractor & Eisenberg, 1990:147).

To some extent problems 1 and 4 are addressed by Contractor & Eisenberg (1990) who explicitly draw on Anthony Giddens' (1984) structuration theory. Following Giddens, they criticize the assumptions underlying contingency approaches from a somewhat different angle than Fulk et al. and stress (1990:145) that receivers are not passive, but active co-constructors of meaning, who have multiple rather than single goals at any given moment, and who operate in a specific context that influences the meanings that are created in communication processes. Furthermore, they reject the assumption (or ideology as they call it) that effective communication necessarily has a transparent and open character (and therefore that face-to-face communication is the most effective medium); instead they argue that for strategic reasons it can be more effective to use media that filter certain cues (1990:145).

Starting from this point of view, Contractor & Eisenberg propose to extend Fulk et al.'s approach and provide it with both a communication theory and a more recursive interpretation of causality. They propose to take (1) *communication networks* as their unit of analysis, and (2) adopt Giddens' conception of *duality of structures*. Their focus on communication networks leads them to identify attributes of *relations* between actors (at both individual, dyadic and group level[11]) rather than attributes of actors themselves. The concept of duality of structures helps them to show elegantly how these attributes of communication networks can affect media attitudes and use, and how media use affects people's participation in communication networks (and thus attributes of communication networks). Building on Pfeffer's (1982) *emergent perspective* on organizational action and Markus & Robey's (1988) application of it in relation to communication technologies, Contractor & Eisenberg advocate an 'emergent network perspective' for the study of communication technologies in organizations. In this perspective the use of communication technologies and its consequences is perceived as emerging in a largely unpredictable manner from a complex interplay between actors, contexts and technology. The 'emergent network perspective', then, provides a set of concepts and methodological tools that helps us to examine these processes.

Apart from the fact that the second and third problem mentioned in relation to Fulk et al.'s social influence model are not explicitly addressed by Contractor & Eisenberg, I have the impression that they seem to only partially solve the first and last problems. In my view, this is a consequence of their only partial adoption of Giddens' structuration theory. Although the emergent network perspective does indeed imply a focus on communication, it is not a communication theory in the sense that it gives us a fundamental insight in the processes through which meaning is created, and in how social structures impinge on this. Instead, the approach proposes to use a number of descriptive attributes of social relations that allows us to examine, rather than understand, patterns of change in communication networks. Thus, we are left with essentially the same questions that I posed in relation to Fulk et al. in this respect. On top of that, these attributes leave us with a number of methodological questions[12]. What is lacking, in short, is a clear definition of structure itself and its interrelation with meaning and communication.

Even if they explicitly deny so, Contractor & Eisenberg still deal with the recursive nature of social structure (as implied by Giddens' notion of 'duality of structure') in a rather *sequential* manner. Basically, they colourfully point out how certain network attributes can influence media use and adoption, and how, *after* the introduction of a communication technology, a chain of interactions can occur as a result of which network attributes can change. In Giddens' terms they describe how patterns of relations in *social systems* (described by him as reproduced relations between individuals and/or collectives in time and space) change over time, and in an often unintended manner. By labelling this as a recursive process, they do in fact deviate from Giddens who uses the concept of recursiveness and 'duality of structures' primarily to show how *social structures* (described by him as recursively organized rules and resources) are *at the same time* (*simultaneously* instead of sequentially) produced and reproduced in social interaction.

It is in fact this mix-up between system and structure that prevents Contractor & Eisenberg from getting at the core problems of understanding the use and development of communication technologies. Consequently, their 'emergent network perspective' is rather descriptive, and does -like other social influence models- only partially meet the criteria that I have formulated at the outset of my theoretical explorations. In particular, these approaches fail to conceptualize fully the social and historical dimensions of knowledge, information, and communication technology mediated interactions.

4.2 Extension science and general communication science

In the last decade studies focusing on the relation between communicative intervention and behavioural change have -at Wageningen Agricultural University and increasingly in other parts of the world as well- been pursued under the banner of 'extension science'. The theoretical basis of this applied science overlaps considerably with that of general communication science (see e.g. Bosman et al., 1989). In both fields of study authors have tried to explain and improve the effectiveness of communication technologies. Unlike other fields of study, there is nowadays a tendency in extension science to focus on both the context in which communication takes place, and the *content* of what is being communicated, as elements to understand and explain the use and development of communication technologies.

In the early days of extension science, extension scientists were primarily interested in issues relating to the adoption and diffusion of innovations, and the prospects of particular media and methods of getting certain messages and/or technological packages across (Havelock, 1969; Rogers, 1983). As Röling & Engel (1990:7) point out the question of "how do we get the message across?" was soon followed by the question "why don't they do what we want them to do?". At first it was tried to discover the (socio-psychological) causes of what was termed audiences' 'resistance to change', 'lack of innovativeness' and/or 'traditionalism'. At a later stage the theoretical models developed in relation to these themes were complemented with marketing approaches (Kotler 1985) and planning models (Van Woerkum, 1987a) in an effort to induce better targeting, greater client-orientation and higher effectiveness of extension practice (Wapenaar et al., 1989).

In recent days we see a break-away from the narrow focus on interactions between extension agents and their clients which characterized these earlier approaches (as epitomized by e.g. Van den Ban & Hawkins, 1988[13]). This shift reflects extension scientists' increasing awareness that the 'offerings' (i.e. messages and technologies) which are communicated by extension agents are often quite problematic. It was realized that nature and appropriateness of such offerings were not only influenced by extension, but also by research, technology development, policy, market conditions, etc. (Röling & Engel, 1990:8). Thus, the first criterion formulated towards the end of chapter 2 reflects a more general acknowledgement that communicative interventions in agriculture take place in a complex '*multi-actor*' setting. In order to deal with the multi-dimensional character of the context in which technologies are applied, several authors have stressed the importance of participatory research techniques for designing messages and technologies, for example, in what became known as 'farming systems research' (e.g. Ascroft et al., 1973; Röling, 1988; Fresco, 1984).

At present we see two approaches within extension science which try both to incorporate these insights and -in relation to this- conceptualize a new role and position for communicative intervention (i.e. extension). The first approach can be labelled the *'knowledge and information systems perspective'* (Röling, 1985, 1988; Engel, 1990; Röling & Engel, 1990; Kaimowitz, 1990; Van Beek, 1991; Havelock, 1986; Beal et al., 1986). Essentially it is proposed in this approach that extension can -amongst others- have a facilitating function in processes of joint social learning, and thereby in the development of higher quality collective agency. This, then, is seen as a crucial prerequisite for solving environmental problems and other social dilemmas. The second approach can be termed the *'policy instrument perspective'* (Van Woerkum 1990a, 1990b; Van Woerkum & Van Meegeren, 1990; Koelen 1988; Damoiseaux et al. 1987). Herein extension is conceptualized as a policy instrument which -in a particular context- needs to be carefully coordinated with both other policy instruments relating to a particular policy and those relating to other policies. Like the KIS perspective the PI perspective has a participatory dimension in that it is claimed that the effectiveness of communicative interventions which are aimed at getting a given policy accepted, can be related to the nature of communicative interventions which are applied in the process of policy formation (Aarts & Van Woerkum, 1992).

The knowledge and information systems perspective

Within the knowledge and information systems (KIS) perspective, Van den Ban & Hawkins' (1988:11-12) conception of extension as 'help' in opinion formation and decision making, is replaced by a slightly more political conceptualization of extension as: "A professional communication intervention deployed by an institution to induce change in voluntary behaviours with a presumed public or collective utility" (Röling, 1988:49)[14]. As we have seen, it is not considered helpful in this perspective to look at extension agent/client interactions in isolation from other interactions. Therefore, it is proposed to study 'knowledge and information processes' in general, within the context of what has been termed knowledge and information systems (KIS); that is, an aspect system of a wider social system that can be more accurately defined as[15]:

> "the persons, networks and institutions, and the interfaces and linkages between them, which engage in, or manage, the generation, transformation, transmission, storage, retrieval, integration, diffusion and utilisation of knowledge and information, and which potentially work synergically to improve the goodness-of-fit between knowledge and environment, and the technology used, in a specific domain of human activity" (Röling & Engel, 1990:8).

In Röling & Engel's view (1990), the notion of a KIS is merely an idealtypical construct which can be imposed "when we anticipate that the solution to problems experienced in an HAS [human activity system] lies in improving the manner in which goodness-of-fit between knowledge and environmental opportunities is attained" (1990:10). Even if they recognize that KIS do not somehow lead a life of their own, Röling & Engel maintain that, in order to change social outcomes (or 'system performance' as they call it), it is useful to look at (knowledge intensive) human activity systems (HAS) as if they were KIS. The KIS perspective, then, is to be seen as a practical tool for problem solving within the boundaries of what is perceived as an HAS. Therefore, it is not surprising that authors in this tradition have drawn upon Checkland's (1981) Soft Systems Methodology (SSM) to develop participatory methodologies for the analysis and subsequent improvement of existing KIS. Engel et al. (1990), for example, developed the RAAKS (rapid appraisal of agricultural knowledge systems) methodology, in which an important element is reaching a certain level of consensus about the KIS boundaries and mission(s). In fact, such methodologies are seen as important tools for what is termed 'knowledge management'; that is, management activities aimed at encouraging actors to act synergically, so as to ensure that "their combined contribution becomes more than the sum of their individual contributions (Röling & Engel, 1990:8), or -in other words- to attain the desired 'emergent properties' of the system. Röling & Engel (1990:10-11) thereby assert that: "In some cases, a KIS is managed centrally. Usually, however, the various institutions comprising the KIS are more or less autonomous so that knowledge management can come about only through shared learning, joint decision-making, a 'corporate' awareness of belonging to a KIS, and external pressures created through such aspects as policy, market forces, or the threat of environmental calamity". 'Knowledge managers' can presumably draw upon experiences and insights that were developed in other contexts. With respect to agricultural knowledge and information systems (AKIS), for example, Röling has collected a large number of so-called 'AKIS disorders' or 'pathologies' that can serve as diagnostic concepts (1989:21). Similarly, Röling & Engel (1990) present a number of normative requirements that should be met in order to create well performing KIS.

The KIS perspective has much in common with Checkland's soft systems approach (see section 3.3) and it therefore shares a number of conceptual and practical problems, which I will not repeat extensively at this point. Suffice it to say that there seems to be a tension (or confusion) between, on the one hand, the KIS perspective as a (quite legitimate and popular) 'practical tool', and, on the other, the ambitions that can sometimes be identified in KIS discourse and writing that the KIS perspective would provide an adequate theory for understanding and explaining knowledge processes in processes of social change and intervention. I would argue that -to the extent the KIS perspective is to be seen as a explanatory theory- there are a number of conceptual difficulties related to issues of teleology and reification (see for more details Leeuwis et al., 1990). Also, there are a number of intricacies in relation to the conceptualization of especially knowledge, information, communication and power. Before elaborating on the consequences of the KIS perspective for the study of the use and development of communication technologies, I will pay some attention to these difficulties.

Definitions of knowledge and information from a KIS perspective

Röling & Engel define knowledge as something that "occurs between the ears, a property of mind. It cannot be heard , seen, or touched" (1990:7), whereas they regard information as "a crucial interface device" that can be defined as "sensory input that maintains or improves the goodness-of-fit between knowledge and the real world". At first sight, Röling & Engel's definition of information strongly resembles the definition of computer scientists like Van Ammers et al. (1991) (see section 3.1). However, Röling & Engel -unlike Van

Ammers et al.- make clear that they are aware that it is at least problematic to assign objective qualities to information:

> "On the one hand, information is explicit, visible, touchable, hearable, and thus is transferable. It consists of matter and energy. On the other, information assumes that a receiver can impose a pattern upon this matter/energy so that it takes on meaning and makes sense. Information, therefore, is more than data or mere sensory input. It also implies an interpretable pattern. Information must not only anticipate its receiver's ability to interpret it, but, to be informative, it must also anticipate an existing discrepancy between the receiver's knowledge and the environment. Deliberate information provision through communication must pay considerable attention to anticipation. (...) Its anticipatory nature is a crucial difference between our concept of information and the one used in computer science" (1990:7).

Although this definition and elaboration on information clearly reflects some of the paradoxical and fascinating aspects of it, it remains -in my view- unsatisfactory. First, stressing that information is an interface device between "knowledge and the real world" seems to suggest a rather sharp distinction between the two, whereas -even if we assume for a moment that there somehow exists an objective natural/physical world- it can be argued convincingly that we can only assign meaning to natural and/or social 'sensory input' on the basis of an existing body of knowledge that an actor has developed over time. Thus, speaking of the "real world" becomes rather problematic. A consequence of this is that the difference between knowledge and information becomes vague as well, since:

> "Both are in fact elements of a single interpretative process, since information has no meaning if it cannot be internalized, and by being internalized, it becomes part of a stock of knowledge. It is not helpful therefore to dichotomize the two" (Leeuwis, Long & Villarreal, 1990:20).

Second, by straightforwardly describing information as matter and energy with an interpretable pattern (singular!), Röling & Engel suggest that it has a meaningful existence of its own in the process of being communicated. I would like to stress, however, that a social (and even a truly subjective) conceptualization of information would imply that "matter/energy" as produced by a 'sender' inherently has a different meaning for the 'sender' than for the 'receiver'. Thus, one could argue that there is a difference between 'information(sender) at t=0' and 'information(receiver) at t=1'. Strictly speaking, neither in or after the communication process the "matter/energy" has an unambiguous meaning. Certainly the "matter/energy" had a "interpretable pattern" for the sender, and will have a "pattern" for the receiver, but in the process of communication we can only speak of *potential* patterns or meanings (plural!). Even if there are differences between communication processes among human beings, and interactions between human beings and the natural world, the conclusion that no unambiguous meanings are 'exchanged' remains valid[16].

My third and most important critique with regard to Röling & Engel's definition of knowledge and information is that their definition seems to stress the individual cognitive aspects of information, knowledge and communication, at the expense of the social aspects. In fact, this state of affairs is a direct consequence of their attempt to distinguish conceptually between a knowledge and information system as an *aspect* system of a wider social system. Their definitions fail to recognize that the production of knowledge and information in interaction is inherently a social process in which both power and normative interests can play an important role. Knowledge processes are social processes, and especially if it comes to understanding why knowledge processes take place as they do, it is not helpful to disconnect them deliberately from other processes that take place in social interaction. Even if KIS thinkers recognize that one has to study communication processes against the context of other communicative interactions in time and space, I would add that the scope needs to be widened even more, and that we must study knowledge processes in their connection with other processes.

In line with these criticisms, I propose not to make sharp distinctions between knowledge, information and data. Even if in the remainder of this book I cannot always avoid using terms such as 'information', 'data', 'parameters', 'texts', 'meanings', 'models', etc., it is important to keep in mind that -in essence- I am speaking about what might best be called '*knowledge constructs*' of various levels of complexity and concreteness. Similarly, it may - in order to emphasize the social and historical character of human beings- be more appropriate to speak of actors and/or individual actors rather than of just 'individuals'. In chapter 5, I will elucidate further on these proposals.

The KIS perspective and power

Of course, the concept of power is not totally absent within the KIS perspective, but as I will argue below, it tends to be either treated as a variable that belongs to the KIS environment, and/or it is dealt with in a rather structuralist or functionalist manner.

As Van Woerkum (1990a) points out, there is a strong tendency among authors adopting an (A)KIS perspective to banish actors that may be able to (de)mobilize a number of crucial resources for an (A)KIS (e.g. policy makers) to the realm of the KIS environment. Röling & Engel, for example, assert that "external economic and other factors, often manipulable by policy, have their own role to play in affecting KIS performance" (1990:13). Similarly, both Kaimowitz (1990) and Engel & Seegers (1991) explicitly draw on Mintzberg's (1983) perspective on the relation between the coordination within organizations and the environment in which they operate. Kaimowitz, for example, speaks of 'external pressures' from policy makers, foreign agencies, private firms, etc., as 'moving forces' of AKIS, while Engel & Seegers speak of (several types of) empirically distinguishable industry-driven, national policy-driven, donor-driven, research & development-driven and user-driven systems. Within this framework, some interactions between the system and its environment are regarded to be more important or dominant than others, which somehow affects the interactions within the total system. A normative claim that is frequently made in relation to this is that, in order for a KIS to be effective, a certain balance of power is required. Röling & Engel, for example, state that: "Optimal KIS performance requires a balance between the intervention power of specialized institutions and the countervailing power of clients" (1990:11).

Even if some of these concepts are appealing, they are in fact reified, and tend to have deterministic implications. Moreover, they certainly do not clarify how power relations affect the knowledge processes that take place in interactions within the system. Furthermore, I agree with Van Woerkum (1990a) that, if we can not explain much of the dynamics of a system by referring to the forces within it, the boundaries must be chosen differently.

Let it be clear that I am not simply pleading to change KIS boundaries to involve different actors as well. Instead, I am pleading once more to study knowledge processes in *social systems*, rather than looking at them in isolation from other processes in an *aspect* system.

Communication technologies from a KIS perspective
From a KIS perspective communication technologies can be seen as linkage devices within KIS, and therefore as possible tools for knowledge management in addition to other tools such as the more 'conventional' media, organizational arrangements, etc. (Röling & Engel, 1990; Engel, 1990). In line with Röling & Engel's definition of information, the key-word in the explanation of the effectiveness and adoption of communication technologies is *anticipation*. That is, CT can, for example, fail to foresee (or anticipate): (a) the information needs and/or interpretative frameworks of farmers (i.e. *the receiver*)[17]; (b) the practical procedures of problem solving that farmers and extension workers employ in their interactions (i.e. *specific KIS-interactions*)[18]; (c) the information that farmers already obtain through other sources (i.e. *networks of KIS-interactions*)[19]; and/or (d) the natural, economic, material, political and cultural constraints and opportunities which characterize the context in which they are applied (i.e. *the KIS-environment*)[20].

In order to prevent such anticipation problems, KIS authors suggest to focus on the process of CT development. In this process, and analogous to the development of 'conventional' communication technologies and messages, they stress the importance of user-research, targeting, participatory technology development, countervailing power, systematic planning, network analysis, systems analysis, etc. (Leeuwis, 1989; Wapenaar et al., 1989; Röling, 1988; Van Woerkum, 1987a, 1990c). Many of these elements can be found again in the tools that are provided by Engel et al.'s (1990) RAAKS method (see also Engel & Salomon, 1993).

At first sight the KIS framework seems to provide us with a fairly illuminating framework to analyze problems in relation to the use and development of communication technologies. However, I have to add immediately that it is predominantly a *descriptive* framework; it merely describes *that* and *which* different types of anticipation problems exist. The 'diagnostic value' of such descriptions, in my view, remains limited since the KIS framework does not provide many tools to understand *why* and *how* such anticipatory 'misfits' have come into being. Following the KIS framework we would in the end have to assume that producers and developers of communication technologies are simply quite ignorant, and that, by using soft systems methodologies, we can create the necessary illumination and consensus in order to prevent and correct such mistakes. Here we seem to have found a relic of the optimistic 'enlightenment' thinking that characterized the early days of extension and extension science.

In essence, the KIS perspective fails to deal with the political and normative dimensions (i.e. the social nature) of anticipatory 'misfits', and the active processes through which they emerge. More in general, it can be argued that the KIS perspective neither helps us to understand the social dimensions of knowledge, information and communication, nor does it provide an active conceptualization of human action. Thus, this approach too does not meet the criteria that I have formulated at the outset of my theoretical explorations.

The policy instrument perspective

Whereas within the KIS approach extension is increasingly seen as a facilitating function in achieving social change on the basis of negotiated consensus, it has, in the policy instrument (PI) perspective, remained -and even more explicitly become- a legitimate instrument in the hands of institutions (e.g. 'the state') to change people's behaviour into a desired direction.

As Van Woerkum (1990b) points out, the instrumental aspect of (especially government) extension has, because of its political and ethical implications, long been a taboo. One could argue that conceptualizations of extension as 'help' (see e.g. Van den Ban & Hawkins, 1988) have been quite helpful in mystifying this clearly instrumental aspect. Instead, Van Woerkum prefers to accept that, in actual practice, extension *is* an instrument that policy makers invest in, in order to reach their goals in a non-violent and non-coercive manner. His criticism of the KIS perspective, then, derives from the assessment that -with the banishing of policy-making institutions to the KIS environment- the instrumental interests of the facilitator again remain hidden. Van Woerkum (1982:39), therefore, defines extension as "helping behaviour consisting of -or preceding- the transfer of information, usually with the explicit intention of changing mentality and behaviour in a direction that has been formulated in a wider policy context" (transl. CL).

The policy-instrument perspective, which is sometimes referred to as the 'persuasive' model of extension[21] (Van Woerkum, 1987b; Wapenaar, 1989; Röling, 1988), finds its origins and its most visible area of application in the field of health and environmental education. Not surprisingly, these are areas in which -at least in the Dutch context- there seems to be a reasonably general consensus that 'healthy' and 'environmentally friendly' behaviour are in the long-term interest of both the government and the public, and therefore to be stimulated.

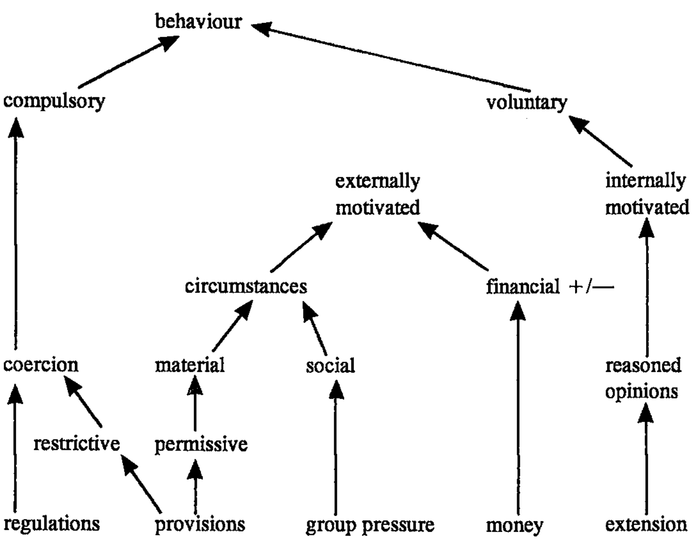
The social psychological approach within the PI perspective

Both Van Woerkum's and Röling's conceptualization of extension stem from the conviction that extension can only be effective through the voluntary change of behaviour (Röling, 1988; Wapenaar et al., 1989:20). Apparently, as is illustrated by a 'sorting scheme' introduced by Van Woerkum (see figure 4.1), a rather strict distinction is made between 'voluntary' and 'non-voluntary' (or 'compulsory') behaviour.

As Van Woerkum (1990b:268) points out in his 'sorting scheme' 'compulsory' behaviour can arise from coercion that derives from the sanctioning of laws and regulations or constraints in available provisions. Voluntary behaviour, then, can be either 'externally' or 'internally' motivated. 'Externally motivated' voluntary behaviour originates from material and social circumstances or financial impulses (subsidies/taxes) as brought into being by the corresponding policy instruments. 'Internally motivated' voluntary behaviour is seen as arising from reasoned opinions that can be influenced by means of communication/extension.

Van Woerkum stresses that it is important to recognize that communication is not a particularly 'strong' policy instrument, and that a careful balance needs to be worked out between extension and other policy instruments. In some cases, extension could play a dominant role in the 'intervention mix', for example in cases where the visibility of the desired behaviour is limited (so that the behaviour is hard to control), when sanctioning is very expensive, or when a quick response is needed in absence of a suitable legal framework for sanctioning (persuasive extension). In other situations, extension could be subordinate to other policy instruments and limit itself to merely communicating the existence of regulations, sanctions, provisions, subsidies, taxes, fines, etc. (informative extension). In more ambiguous cases, extension and other policy instruments could play a more complementary role in efforts to change people's behaviour (Van Woerkum, 1990b:269-270). Lastly, but distinct from the dominant/subordinate/complementary classification, Van Woerkum recognizes that extension can play a role in the formation of policy itself; that is, it can be used as a participatory tool for the interactive production of policy (participatory extension) (van Woerkum, 1990b:272).

Figure 4.1: The relation between extension and other policy instruments aimed at stimulating behavioural change, as conceptualized by Van Woerkum (1991b:268)



Even if Van Woerkum describes his model as a 'sorting scheme' without scientific pretensions (1990b:267), I would argue that it draws on several non-trivial theoretical assumptions which originate mainly from social psychology, and therefore, that it is not as 'innocent' as presented.

Most importantly, the part of the model dealing with voluntary behavioural change seems to be strongly inspired by Fishbein & Ajzen's (1975) model of reasoned action; a model which has become very popular within the policy instrument perspective (see e.g. Wapenaar et al., 1989; Damoiseaux et al., 1987; Bosman, et al., 1989). In this model, people's intentions are seen as immediate determinants of action (Ajzen & Fishbein, 1980:5). These intentions are seen as "a function of two basic determinants, one personal in nature and the other reflecting social influence" (1980:6) (note the parallel with Van Woerkum's 'externally motivated' and 'internally motivated' voluntary behaviour). The personal factor is called *attitude toward the behaviour*; that is, "the individual's positive or negative evaluation of performing the behaviour" (1980:6). This attitude, in turn, is "a function" of "behavioural beliefs" (1980:7) which can be described as "the person's beliefs that the behaviour leads to certain outcomes and his evaluations of these outcomes" (1980:8). The social influence factor is termed *subjective norm*; that is, "the person's perception of the social pressures put on him to perform or not perform the behaviour in question" (1980:6). Subjective norms are seen as "a function" of "normative beliefs" (1980:7), which are described as "the person's beliefs that specific individuals or groups think he should or should not perform the behaviour and his motivation to comply with the specific referents" (1980:8).

In cases where there is a conflict between a person's attitude toward a behaviour and his or her subjective norm, a person's behaviour can, according to the model, be effectively predicted if one knows "the relative importance of attitudinal and normative considerations" (1980:8), which are assumed to depend in part on the intentions under investigation.

Clearly this model, which is primarily aimed at predicting and understanding human behaviour, allows for all sorts of informational interventions aimed at influencing people's normative and behavioural beliefs, and/or their evaluations concerning the relative importance of attitudinal and normative considerations. Even if popular, the model of Fishbein & Ajzen -and therefore to some extent Van Woerkum's 'sorting scheme'- is rather problematic:

(1) The model of reasoned action explicitly starts from the assumption that people consciously "consider the implications of their actions *before* [emphasis CL] they decide to engage or not engage in a given behaviour" (Ajzen & Fishbein, 1980:5). In this respect the model is related to approaches which portray human beings as rational decision makers. However, sociologists like Giddens (1984) and Bourdieu (1990) have -at least at the conceptual level- convincingly shown the importance of routine in the everyday practice of social life.

The reasoned action model has also been criticized from within social psychology. In the context of persuasive communication, for example, Petty & Cacioppo (1986) argue that attitudes do not only change through what they call the 'central route'; that is, "a person's careful and thoughtful consideration of the true merits of the information presented in support of an advocacy" (1986:125), but also through what they call the 'peripheral route'. Persuasion through this peripheral route is seen as "a result of some simple cue in the persuasion context (e.g. an attractive source) that induced change without necessitating scrutiny of the true merits of the information presented" (1986:125).

Partly in line with Petty & Cacioppo's elaboration likelihood model (ELM) of persuasion, several authors have stressed the role of emotions in persuasive communications, i.e. the interrelationships between cognitions and emotions (see e.g. Pieters & Warmerdam, 1991; Van Woerkum, 1991; Pieters & Van Raay, 1988; Van Raay, 1983). However, even if these critical approaches ameliorate some of the shortcomings of Fishbein & Ajzen's model of reasoned action, they -like Fishbein & Ajzen- leave several additional issues unsolved.

(2) The sharp distinction that is made between social (external) and personal (internal) influences, and thereby the treatment of subjective norms and attitudes towards behaviour as independent entities, seems in many ways artificial. On the basis of Giddens' theory of structuration, for example, it can be convincingly argued that -in time and space- there is a complex interaction between people's 'normative beliefs' and their 'behavioural beliefs' (see section 5.3). Similarly, the 'beliefs' or interpretations that people draw upon in their

behaviour are likely to be affected by the operation of power and interests, which in Fishbein & Ajzen's model do not even belong to the realm of 'external variables'[22]. This neglect of the socially constructed nature of 'beliefs', 'subjective (instead of social!) norms' and 'attitudes' reflects: (a) the strict focus on individuals in isolation from other individuals, rather than on a socially situated (individual) actor, and (b) the largely a-historical character of the model. Even if the individuals in the model are perceived to anticipate outcomes and sanctions, the model seems to depict people's actions as a discrete series of intentions, decisions and behaviours, without making a connection between the different actions in time and space.

Again, some authors within the policy instrument perspective recognize at least part of these problems (Damoiseaux et al. 1987; Koelen, 1988; Bandura, 1986). Bandura, for example, has emphasized that a person's perceived self-efficacy[23] (as influenced by previous experiences) too "is a significant determinant of performance", amongst others in that it influences a person's attitudes (1986:391). Furthermore, Koelen draws on the works of Goffman (1959) in what she calls "a self-representational view on health-related behaviour" (Koelen, 1988). In her study on smoking behaviour, Koelen shows that smoking behaviour has to be seen in the wider context of adolescents' life-styles and social networks. Within these networks, the attributions that people make (i.e. the cognitive beliefs they put forward) can serve self-presentational purposes. Thus, she concludes that purely cognitive approaches towards behavioural change (e.g. on the basis of attribution theories (Kelley, 1973; Jones & Davis, 1965)) have important shortcomings, and furthermore that "an approach toward a single behaviour [i.e. based on the Fishbein & Ajzen model, CL] does not lead to a powerful intervention" (1988:99). In fact, Koelen's argument can be seen as a strong plea for a more sociological approach towards extension processes. A final problem that remains with both Bandura's, Koelen's, Ajzen & Fishbein's and Van Woerkum's work is, however, that it has deterministic implications.

(3) In my view, the social psychological approach within the policy instrument perspective starts from a rather reactive and passive view of human behaviour. The authors within this field are primarily interested in what 'determines' human behaviour, and in the process of doing so they tend to portray individuals as reacting to certain outside impulses, whereby 'beliefs' seem almost mechanically to result in 'attitudes', 'subjective norms', 'social pressures' (Koelen, 1988) and 'intentions', which are referred to as *'determinants of behaviour'*[24].

The model fails to see actors as active social agents that have long-term or short-term strategies, projects, etc. As soon as one starts to look at actors as having agency (that is, the capacity to make a difference), Van Woerkum's and Röling's distinction between voluntary and non-voluntary behaviour becomes rather vague and gradual. Both power and constraints play a role in all human (inter)action, but are at the same time enabling, and leave a certain space for manoeuvre. This implies in fact that the concept of 'voluntary change' in both Röling's and Van Woerkum's conceptualization of extension becomes in fact a rather misleading theoretical obstacle if one wishes to understand extension-related social interactions.

The 'receiver-centred' approach within the PI perspective

The receiver (or audience) centred approach within the PI perspective can be seen as a reaction to, on the one hand, the 'media-centred' approach (Bosman et al., 1989; Nelissen & Renckstorf, 1991; see also section 4.1), and on the other, the social psychological approach. As we have seen both approaches have much in common with respect to the conceptualization of human action as a rather passive (if not externally determined), mechanical, rational, and individual process. Furthermore, neither of these approaches have seriously problematized concepts like information and knowledge. Information in these approaches has been primarily looked at as an objectively existing phenomenon with a fixed meaning that was either to be transferred by means of a (hopefully) appropriate medium, or to function as an external stimulus in the process of persuasion.

In the receiver-centred approach, communication scientists and extension scientists (Bosman et al., 1989, 1990; Van Woerkum, 1990d) try to rectify this conceptualization. Thereby, they draw upon insights from interpretative sociology (Schutz, 1972), and much more recent translations of Schutz' work toward communication science, for example Dervin's 'sense-making' approach (Dervin, 1981, 1983).

Dervin proposes a much more active and subjective conceptualization of information, and argues that "information cannot be treated as a brick thrown from system to user, but like clay the user can use for constructing his or her sense" (Dervin, 1983:173 as cited in Bosman et al., 1989:28). Knowledge, then, is perceived as a "user construct of information" (Bosman et al., 1989:28). Following Schutz, Bosman et al. speak of a "social stock of knowledge" and of an individual or subjective stock of knowledge, and the interaction between the two (1989:66-67), that actors can draw upon in their production of information and the adaptation of their (individual and/or collective) stocks of knowledge.

In my view, these conceptualizations of knowledge and information are very similar to the ones adopted in the KIS perspective, and therefore run into exactly the same problems with regard to the difference between knowledge and information, the assumed existence of information with an unambiguous meaning[25], and the social nature of knowledge and information. Even if authors within the receiver-centred approach speak of the "social construction of reality" and a "social stock of knowledge" (Bosman et al., 1990:20), they seem to only mean that an individual's subjective stock of knowledge is closely connected to a social/collective stock of knowledge, and that both have been developed through past experiences and learning. However, they maintain that it is the *individual* who, to paraphrase Dervin, 'constructs sense out of the clay', rather than also recognizing that -at the moment of this construction (and not only in the past)- such an individual is part of a specific social setting in which *other actors* are often actively involved in influencing and shaping an individual's production of sense or meaning.

Although Dervin (1991) recognizes the importance of contextual aspects of knowledge and information, she tends to represent the social context as an arena in which (as a result of diverging perspectives) there are numerous 'gaps' that need to be 'bridged'. Dervin's sense-making methodology (not unlike the soft systems methodologies), then: "rests on a core gap metaphor which posits humans facing stops (that moment where a gap is seen ahead) and constructing bridges in order to keep moving through internal and/or external time-space" (Dervin, 1991:51). Thereby she fails to acknowledge that human beings are not only trying to solve interpretative discontinuities, but that they are also actively and strategically involved in creating them, and/or 'solving' them in a *specific* manner. Thus, she disconnects interpretative discontinuities from other types of discontinuities; that is, discontinuities related to political and normative interest.

The neglect of social processes in human interaction within the receiver-centred approach is also reflected in the conceptualizations proposed with regard to rationality and decision making. Although Bosman et al. (1989:73-74) recognize that decision making is not a straightforwardly rational and/or reasoned process, and that it can be more adequately understood in terms of decision *strategies* (Janis & Mann, 1977) than in terms of formal models of rational decision making, they fail to depict it as a process with a social dimension. In fact, the social dimension of decision making is included only to the extent that Fishbein & Ajzen (1975) include it (Bosman et al., 1989:75, 106-107). Furthermore, their conceptualization of 'information needs' in decision-making processes as essentially individually "experienced discrepancies between existing knowledge and new information" (Bosman et al., 1990:22-23)[26] too reflects an abstraction from the social contexts and interactions in which information needs emerge[27].

Communication technologies from a PI perspective

The receiver-centred approach within the policy instrument perspective[28] does not add a great deal of insight on the understanding of the use and development of communication technologies other than those already discussed in relation to the KIS perspective. Dervin, for example, establishes that -despite their theoretical potential- present-day communication technologies: (a) fail to intelligently deal with diversity; (b) are still mainly transmission systems rather than communication systems (that is, they depart from an information as commodity or 'brick' metaphor); and (c) tend to rip information out of its context, and are therefore more likely to support the production of non-sense rather than sense (1991:53-54). Thus, in essence she arrives at similar conclusions with regard to the importance of *anticipation* for 'effective' communication by means of communication technologies (see also Slaa, 1989; Bouwman & Veneboer, 1989; Neijens, 1989; Van Rijn, 1989), and at a focus on interpretative methodologies for coming to grips with such situations (see e.g. Bosman et al., 1989; Renckstorf, 1991; Frissen, 1991).

An interesting, but normative rather than explanatory, issue that may have special relevance to communication technologies, is raised by Van Woerkum. Obviously, Van Woerkum is aware of the ethical questions that can be raised in relation to extension in general and the most blatant 'persuasive' variants in particular[29]. In a discussion on the legitimacy of making emotional appeals in persuasive extension, Van Woerkum takes the view that this would be legitimate if it does not hamper rational decision making (1991:270). He argues that emotions can interact with cognitions in several ways that do not violate the principle of rationality, for example, drawing attention to certain issues, creating interest through emotional arousal, supporting the long term remembering of messages, and the actualization of existing knowledge (Van Woerkum, 1991:270-274), In relation to the last point Van Woerkum makes clear what his concept of rationality is, when he argues that emotional appeals are only justified "to the extent that a reasonable elaborate mental set of arguments, based on empirical evidence, is available to the receiver" (1991:273-274, transl. CL).

Apparently, he considers it a task of extension to provide such 'empirical evidence', and not to mystify the empirical basis of certain messages.

Although I will argue in chapter 5 that the notion of 'empirical evidence' is problematic, my main interest at this point is to draw a parallel between the use of emotional appeals and the use of communication technologies. Many communication technologies in agriculture appear to be based on very complex scientific models, and even if scientists would claim that they are based on empirical evidence, they do certainly not provide the users with all the underlying arguments and assumptions. Of course, it could be argued that this is the case with 'traditional' communication technologies as well, but nevertheless it is quite striking that, although a complex model has been necessarily made very explicit (at least to such an extent that it is programmable), it often remains largely hidden for the user. In that sense computer programs tend to mystify arguments, in a similar way as emotional appeals can do.

Conclusion: towards sociological conceptualizations in extension science

In sum, it can be argued that neither the receiver-centred approach -even if in some respects an improvement when compared with the media-centred approaches (see section 4.1)- nor the social psychological approach within the PI perspective provide conceptualizations of human action, knowledge, information, rationality and communication that meet the criteria formulated at the outset. Since a similar conclusion resulted from my discussion of the KIS perspective, we can conclude that, although extension scientists are increasingly aware that extension processes need to be studied in a '*multi-actor*' context, this assessment has so far not resulted in the development of conceptualizations that are in line with it. That is, the social dimensions of knowledge, information, communication and rationality are insufficiently explicated, and human action remains to be perceived as a rather passive phenomenon.

In my view, adequate conceptualizations in this respect are most likely to be found in sociology, which implies that both extension processes and studies relating to the use and development of communication technologies may best be understood in sociological terms.

Recently, several extension scientists have taken up this theoretical and methodological challenge. KIS adepts, for example, have responded to similar criticisms voiced by extension scientists (Volker, 1983)[30], sociologists (Long, 1989a; Leeuwis, et al., 1990) and philosophers (Koningsveld, 1980; Pijnenburg, 1991) by resorting to Habermas' (1981a, 1981b) theory of communicative action (as connected with 'critical' systems thinking; see e.g. Röling, 1992a, 1992b; Engel, forthcoming; Dissanayake, 1992; Bawden & Macadam, 1991). Similarly, it could be argued that Van Woerkum's normative position that extension should support the process of argumentation and the elucidation of underlying assumptions and claims, quite surprisingly (given the instrumental perspective) leads (or could lead) him into a similar direction as KIS thinkers; i.e. Habermas' theory of communicative action. Others are exploring the opportunities of symbolic interactionism (Wagemans, 1987), discourse analysis (Te Molder, forthcoming), or actor-oriented sociology and Giddens' theory of structuration (Leeuwis, 1991a, 1991b; Dissanayake, 1992).

In the next chapter I will discuss the prospects of several theoretical approaches in sociology for the study of the use and development of CT in agriculture. Before doing so, however, I will in the concluding section of this chapter reflect on a long-standing debate between sociologists and extension scientists with respect to the value of sociological insights for purposes of intervention.

Intervention, knowledge for action and knowledge for understanding

From the foregoing we can conclude that extension science provides a fairly illuminating framework for describing several types of anticipation problems, but that it has little to offer in understanding how and why these anticipation problems come about. In the light of this lack of understanding, the solutions proposed to solve anticipation problems (i.e. user-research, targeting, participatory technology development, systematic planning, using soft systems methodologies, etc.) are based on a rather shallow analysis. Moreover, there is a need to more precisely define the *nature* of the required anticipation, user-research, targeting, participation, etc.

An assumption that underlies my plea for developing sociological conceptualizations in extension science, is that somehow a sociological understanding can lead to better interventions. I am aware that this assumption is far from unproblematic, and that there is a considerable need to clarify how this relationship between understanding and intervention must be conceptualized.

In combatting claims such as made above, namely that there is a need for a more detailed sociological understanding of anticipation problems, extension scientists and interventionists have made grateful use of Scott & Shore's (1979) book "Why Sociology Does Not Apply". In this book it is suggested that we can validly make a distinction between 'knowledge for action' and 'knowledge for understanding'. Along similar lines others have made distinctions between 'applied research' and 'fundamental research' (NRLO, 1989), between 'upstream problems' (pure science) and 'downstream problems' (Box, 1992), between 'social policy research' and 'disciplinary social science' (Van de Vall & Bolas, 1982), and between conclusion-oriented, applied, and decision-oriented sciences[31] (Zwart, 1983; Blokker, 1984). Extension science, then, according to Blokker (1984:9), is an applied and decision oriented science, or, as Röling (1988:61) -following Scott & Shore (1979)- puts it, extension science "does not seek knowledge only for understanding, but also for action".

Thus, in contrast to sociology, extension science needs to provide a theory on how to arrive at B from A (Röling, pers. comm.). According to Röling, especially actor-oriented theorists tend to observe actors' "antics in the arena of life" from their "hide", and find it "preposterous to think of intervening to some useful purpose, let alone that the actors can be considered a system amenable to management" (Röling & Engel, 1990:8-9).

In short, the argument seems to be that sociological knowledge of the type that I would like to provide is not very useful for intervention purposes, and/or that, as Van Dusseldorp (1990:350) puts it, "it is not realistic to say that planned intervention should wait till the sociologists know what is going on". In that sense, the motto of Röling's (1988) book (derived from Gelia Castillo, 1983), which is: "Waiting for perfection is a form of abdication", clearly does not relate to the process of writing a book only.

Central to the debate presented above is the argument presented by Scott & Shore (1979:224-239) that policy makers operate in different contexts than disciplinary academics, and that therefore they have different goals, problems and questions than the latter. The limited use of sociological insights among policy makers, which Scott & Shore empirically establish, assumably arises from this discrepancy, and could be solved when sociologists pay more heed to the policy makers perspective. In doing so, they should engage in interdisciplinary research, provide 'simple' causal explanations and 'robust' theories[32], focus on explanations and theories that include independent variables that are susceptible to control or manipulation, and thereby develop a "Keynesian-like sociological theory of society" (Scott & Shore, 1979:231, following Feuer, 1954:683-684).

Whilst I accept that policy makers and interventionists tend to constitute different cultural communities in which different practices, discourses, questions, goals, etc. arise than in communities of sociologists, and while I agree that sociologists may be wise somehow to anticipate (critically or uncritically) these communities, I have some difficulty in discriminating between the two along the lines of their involvement with either 'knowledge for action' or 'knowledge for understanding'. Below, I will present some considerations which lead to the conclusion that, especially in the social sciences, it may be misleading to make a sharp distinction between 'applied science' versus 'pure science' or 'knowledge for action' versus 'knowledge for understanding'.

First, it is by no means clear when we should describe social scientific knowledge as being applicable. Scott & Shore's conclusions about the limited applicability of the social sciences, for example, are based on a study in which 'applicability' is analyzed in terms of its contribution to the development of specific policy recommendations, and its contribution to enacted policy (1979:14,33). However, even if policy makers may not explicitly refer to social science knowledge in generating policies, it could be argued that -for example if they use 'scientific planning' procedures as advocated by Scott & Shore (1979:70)[33]- they implicitly draw upon several very 'abstract' social scientific notions with regard to the nature of human action, rationality, knowledge, information, etc. Thus, if 'practical' models (i.e. planning models) are based upon, or correspond with, 'theoretical' models, it would not be very logical to claim that these theoretical models cannot be applied. If the results of planning are meagre -as is often the case with planned interventions related to communication technologies in agriculture- Scott & Shore's question of 'Why Sociology Does Not Apply' might be suitably rephrased into 'Why Planning Models Do Not Apply' or 'Why Certain Sociologies Do Not Apply'.

To generalize this argument, it could be argued that human action always requires a certain theoretical understanding of the world. These understandings may -in time in space-well be informed by sociological theory. It is through this 'double hermeneutic' of the social sciences (Giddens, 1976:79-80,158-159) -that is, through the phenomenon that theories of the social world can influence social life itself- that even the most 'abstract' sociological theory can have practical implications.

A second important issue is the question of applicability *for whom*. Scott & Shore apparently identify policy makers as the reference point for operationalizing 'applicability'. This, however, narrows down the scope considerably, and disregards the extent to which others (such as 'ordinary citizens', interest-groups, politicians, private firms, etc.) incorporate social scientific insights into their discourses and day-to-day practices (see also Weiss, 1980). More than likely, different actors in a specific context would have different evaluations of the 'applicability' of certain social scientific insights, which can -amongst others- be traced back to their particular interests. Rendering a social scientific statement as 'non-applicable' when policy makers label them as such (as Scott & Shore seem to do) is as much as denying the political connotation of applicability, and in fact suggests that sociologists should at all times further the interests of a legitimately chosen government. In my view this is far too narrow a view of the role of scientists in democratic societies.

Third, one of the assumptions made by Scott & Shore and others is apparently that 'disciplinary', 'theoretical' or 'fundamental' research addresses problems which arise from the discipline as such (1979:224). Picturing social scientists as isolated actors whose theoretical research is disconnected from 'real-life' problems (e.g. Scott & Shore, 1979:224,228), however, seems a gross simplification. At least in the case of the agrarian sociology of rural development, it has been shown that the theoretical questions addressed can be clearly linked to specific socio-historical settings and problems (De Haan & Nooij, 1985). As the term already suggests, it could even be argued that 'postmodernism' is a 'child of its time' in the sense that it expresses, and tries to come to grips with, the diversity, chaos and multitude of perspectives that emerge in 'the global village'.

Fourth, Röling's statement that extension science needs to provide a theory on how to arrive at B from A, is in fact an expression of the legitimate wish not only to explain retrospectively how t=0 came into existence (which, according to Röling, is what actor-oriented sociologists tend to do), but also to understand prospectively how a particular t=1 can be realized. Although I agree with Röling that some sociologists tend to try to keep 'clean hands' (in that they avoid making recommendations for action to policy makers and/or others), and that they may too easily use the 'double hermeneutics' of the social sciences as a pretext for doing so, in my view this does not imply that the retrospective understanding they produce does not have practical implications. In addition, I would like to argue that the validation of any theory that wants to prospectively support going from t=0 to a previously defined situation t=1, can in the end only take place on the basis of a retrospective analysis of how the actual situation at t=1 emerged. Thus, adequate prospective intervention theories can, logically speaking, only emerge from retrospective analysis.

Moreover, I consider the wish to realize certain outcomes as inherent to human action. Therefore, it would -even if their respective desired outcomes differ in nature and/or explicitness- be absurd to fundamentally distinguish between planners, extension scientists, sociologists or even the people they study in this respect. In my experience, the goals (or desired outcomes) of actor-oriented sociologists often remain implicit. This, however, is not to say that -even if their goals are formulated at the personal level (for example, to produce a Ph.D. thesis)- their research activities do not produce outcomes for others as well. In many ways, carrying out sociological research is as much an intervention as applying a soft systems method. The point, then, is that actor-oriented sociologists in many ways -and despite the fact that they have given considerable attention to their own role in the construction of scientific knowledge (e.g. Nencel, 1991; Long & Long, 1992)- have 'forgotten' to study and reflect upon their own role as social actors in the production of social outcomes (see section 6.3 for further elaboration).

In sum, we can say that the between 'knowledge for action' and 'knowledge for understanding' is not as sharp as some authors suggest. As we have seen it is quite possible that the distinction between 'applicable' and 'non-applicable knowledge' is held up for political and institutional reasons. Thus, I consider it legitimate from an extension science point of view to explore the usefulness of developing a more sociological understanding of human action, knowledge, information, rationality and communication, even if previous attempts to do so (e.g. Van Woerkum, 1979) have not resulted in a widespread integration of sociological insights into extension science. However, from an extension science point of view, such an exercise would be rather incomplete without a thorough analysis of the social scientists as actors, i.e. the role of the social scientific researcher in processes of social change.

Notes

1. Although I will draw heavily on contributions collected in an edited book by Fulk & Steinfield (1990) in this section, the distribution of different CMC authors under the classification suggested by Steinfield remains my responsibility.

2. Nass & Mason distinguish between two types of studies in this field; the object-centred type, which takes a material technology as a point of departure, and the social-actor-centred type, in which the primary focus is on the behaviour and attitudes of social actors in relation to technologies. According to Nass & Mason (1990:49) a limitation of most of these studies (whether object- or social-actor-centred) is that the theories built on the basis of them can never be applied to other technologies and/or organizational contexts.

3. Other criteria mentioned by Nass & Mason (1990:51) are: (1) the variables must vary across communication technologies, (2) they must be applicable to past, present and future communication technologies, and (3) they must highlight both similarities and differences between technologies.

4. Advanced information technologies are -largely in line with 'second wave' and hard-systems thinking- defined by Huber (1990:238) as: "devices (a) that transmit, manipulate, analyze, or exploit information; (b) in which a digital computer processes information integral to the user's communication or decision task; and (c) that have either made their appearance since 1970 or exist in a form that aids communication or decision tasks to a significantly greater degree than did pre-1971 forms."

5. They base their somewhat structural functionalist interpretation of symbolic interactionism on Stryker & Statham (1985), who advocate a theoretical framework called 'structural symbolic interactionism'.

6. Which, as I have shown in my discussion of Davis & Olson's (1985:200) definition of information in section 3.2, is not uncommon in the second wave of organization theory.

7. In my definition all communication technologies are interactive in the sense that they play a role in social interactions; the term 'interactive media' in this context, however, is commonly used to describe those media that people use with the explicit aim to interactively communicate with (an)other person(s); e.g. telephone, electronic mail, etc.

8. In the case of decelerating production functions, universal access is not easily obtained either, since, although initial contributions and investments are likely to occur, adoption will slow down as a result of supposedly lower marginal returns for later adopters. Again, the general applicability of these claims can be challenged in the context of agriculture; in many ways it can for example be argued that even if marginal returns for later adopters are lower than for early adopters, they may be 'forced' to adopt because they cannot afford to become isolated from certain institutions and or people. In fact, this suggests that the nature of the returns from adoption can change through time.

9. Social presence theory has much in common with information richness theory as discussed earlier on. An important difference, however, is that a slightly different dimension for the classification of media is chosen in the former. Within social presence theory media are classified according to the extent to which it allows those that interact to be aware of each other and the interpersonal relationship that exists between them. Similarly, tasks are ranked according to the amount of interpersonal involvement that they require. Analogous to information richness theory, the idea is then, that tasks that require a high involvement can be mediated best with the help of high social presence media.

10. In their model they only draw a two directional causal arrow between media use and media evaluations (1990:128).

11. At the individual level they focus on 'key communicators', and are interested to establish the size (absolute number of contacts), connectedness ("the ratio between a member's actual and potential communication links in the network"; derived from Alba, 1982), the centrality (one indicator being "the extent to which a member communicates with others who do not themselves communicate"; derived from Freeman, 1979), and the range ("the degree to which a person communicates with heterogeneous groups of others along some salient dimension"; derived from Rogers & Kincaid, 1981) of a member's communication network.
At the dyadic level Contractor & Eisenberg are especially interested in their strength ("the time spent communicating or frequency of communication"), their multiplexity ("the number of types of relationships (in terms of content or media) that exist between two members", and their structural equivalence ("the extent to which the two members share similar patterns of communication with others in the network"; derived from Burt, 1980).
Finally, at the group level important attributes are size ("the number of members in the network"), connectedness ("the ratio of actual communication links among group members to the number of potential communication links"), heterogeneity ("the degree to which group members differ on key attributes"), and centralization ("the extent to which some group members are more central than others"). (All quotes are from Contractor & Eisenberg, 1990:152-153.)

12. Questions that can be raised are, for example: (1) How can we deal with different interpretations of social actors in relation to network boundaries and other attributes?; (2) Can material objects belong to a network? (3) What about people that others refer to but with whom direct communications have not taken place? (4) Which (and whose) dimensions are to be used in order to classify types of relationships, and/or determine heterogeneity? (5) How to detect Granovetter's (1973) 'weak ties'?, etc.

13. Van den Ban & Hawkins (1988:9) loosely define extension as an activity that "involves the conscious use of communication of information to help people form sound opinions and make good decisions". In their more elaborate definition (1988:11-12) they continuously stress the different aspects in which extension can 'help' people (in this case farmers) to improve their opinion formation and decision making.

14. Röling is certainly aware of the somewhat paradoxical implications of this definition in which extension is apparently seen as a strategic intervention that can only be effective if it is perceived by audiences as 'help'. In fact, Röling argues that this contradiction is one of the most fascinating aspects of extension (1988:49).

15. While writing this book Röling has continuously changed his definition of a KIS, amongst others in response to my own and other scholar's criticisms. The definition presented in the main text is already much more refined (and therefore harder to criticise) than the definition that he held on to in 1989. In 1989 he defined an agricultural KIS as: "a set of agricultural organizations and/or persons, and the links and interactions between them, engaged in such processes as the generation, transformation, transmission, storage, retrieval, integration, diffusion and utilization of knowledge and information, with the purpose of working synergically to support decision making, problem solving and innovation in a given country's agriculture or domain thereof" (1989:1).
In his newest definition, a KIS is described as: "the articulated set of actors, networks and/or organizations, expected or managed to work synergically to support knowledge processes which improve the correspondence between knowledge and environment, and/or the control provided through technology use in a given domain of human activity" (1992b:48).

16. It is important to note that we can in principle make a distinction between "matter/energy" that originates from the natural world and the social world. In the 'communication process' between the natural world and a 'receiver', the latter is in principle responsible for the patterning (interpretation) of "matter/energy", whereas in communication processes within the social world both the receiver and the sender are actively involved in a patterning process. This, of course, is not to deny that within the social world senders frequently make statements about the natural world, and that receivers' interpretations of "matter/energy" that originates from the natural world cannot be understood in isolation from interactions within the social world (in time and space). Not only do people make statements about the natural world, but they are also capable of intervening in it, and using elements in it to construct a physical world which has both natural and social properties (e.g. a building, a city, a nature reserve, a letter, a technology, a farm).

17. See for empirical studies in which problems of anticipating the *receiver* are identified Roep et al. (1991), Leeuwis & Arkesteyn (1991), Leeuwis (1991b), Kruiter & Langen (1988) and Blokker (1984).

18. See for empirical studies in which problems of anticipating *specific KIS-interactions* are identified Engel (1989a), Rommens (1990) and Van Dijk et al. (1991). For other accounts in this respect see Engel (1989b) and Wapenaar et al. (1989:214-218).

19. See for empirical studies in which problems of anticipating *networks of interactions* are identified Box (1990), Van Dijk et al. (1991) and Leeuwis & Arkesteyn (1991).

20. See e.g. Röling (1988).

21. However, in Van Woerkum's view, both 'persuasive', 'informative' and 'educative/participatory' extension can be used as a policy instrument. Therefore, it would be misleading to argue that the policy instrument perspective deals with 'persuasive extension' only (Van Woerkum, 1990b).

22. In the model of reasoned action, beliefs, like people's evaluations of the relative importance of attitudes and subjective norms, are influenced by (and influence) 'external variables', i.e. demographic variables, general attitudes and personal characteristics.

23. Bandura (1986:391) defines perceived self-efficacy as "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances".

24. Only very recently have scholars in this field moved away from such somewhat outdated social psychological conceptualizations, and explored the opportunities of discourse analysis (Te Molder, forthcoming) and/or sociological and anthropological perspectives (Aarts & Van Woerkum, forthcoming) for coming to grips with the active struggles between actors in policy related communication processes.

25. Bosman et al. (1990:29) (in the context of providing alternative ways for extension research to -on the basis of a receiver centred approach- assess media-exposure) introduce the term 'information budget', which refers to "the everyday input of information that originates predominantly from media and the social network" (transl. CL). In relation to this information budget, they argue that there exists an objectively measurable 'information stream': "One can identify with what media and non-media an individual or group of individuals is commonly confronted, and which contents are selected from that (the objective information budget)" (transl. CL). Furthermore, they assume that somehow "the *part* (emphasis CL) of the objective information-budget that is in actual fact subjectively observed (the subjective information-budget) can be established" (transl. CL). Like in the KIS approach, it is apparently assumed that information has an objectively measurable meaning and other quantifiable qualities. In my view, however, such statements as cited above contradict an interpretative (let alone a social) conceptualization of information.

26. When speaking of knowledge and information as knowledge constructs, it would be more appropriate to speak of information needs as 'discrepancies between different elements in existing knowledge'.

27. In fact, the criticism that Van Cuilenburg (1983) raises with regard to the usefulness of present-day techniques for the identification of information needs, reflects exactly the contextual and socially negotiated nature of information needs, when he argues that information needs identified with the help of these techniques are prone to have a 'social desirability bias' and tend to be rather unstable.

28. Within the social psychological approach there has been little systematic attention to the study of the use of communication technologies. Of course, one can easily imagine that social psychological research on this issue would more than likely identify people's 'attitudes', 'subjective norms', 'emotions', 'self-efficacy' and/or 'self-representational purposes' as explanatory elements for the (non) use of communication technologies. However, except for purposes of marketing communication technologies, such conclusions would provide little help in developing more appropriate communication technologies.

29. It can be argued that all variants of extension (informative, persuasive and educative) have in fact a persuasive (and for that matter an informative and educative) dimension. Therefore, the distinction - although it may serve practical purposes- is theoretically weak.

30. Volker was among the first, within the Wageningen Department of Extension Science, to point to the necessity of looking more closely at issues of power and social interests in extension. She did not have the time to complete her work on these issues, as she died in 1983.

31. According to Blokker (1984:7-8), conclusion-oriented scientists aim at understanding and explaining reality. Applied scientists seek to generate results that others may use to intervene in reality,

whilst decision-oriented (extension) scientists aim at generating results that are immediately oriented towards taking specific intervention decisions.

32. 'Simple' explanations that are not just 'intellectually elegant', but explanations that are 'feasible' in that they "reduce a complex question to its simplest forms and identify the minimal, feasible effort necessary to achieve maximally effective change" (Scott & Shore, 1979:226). 'Robust' theories, then, "can be applied with some success even in situations in which assumptions are only partially met" (Scott & Shore, 1979:228).

33. Scott & Shore do recognize certain limitations of scientific planning (1979:134-202), but they mainly describe these as practical problems which do not discredit the scientific planning method as such (1979:135).

Chapter 5

Towards a sociological conceptualization of communication: the prospects of the actor-oriented sociology of rural development, Habermas and Giddens

In the concluding section of the previous chapter I have suggested that for gaining a more adequate understanding of: (a) the active contributions of a variety of actors in a particular context, and (b) the social dimensions of knowledge, information, communication and rationality (i.e. the criteria formulated at the outset of this theoretical exploration) we may benefit considerably from frameworks developed in sociology. From a sociological point of view, these criteria imply that we need to find: (a) a non-deterministic conceptualization of the relation between human action and structure, and (b) that we need to conceptualize how knowledge, communication and rationality are intertwined with this relationship between action and structure.

So far, two possible routes have been suggested for finding appropriate conceptualizations in these respects. Some scholars in information systems research and extension science have suggested that Habermas' theory of communicative action may be fruitful in this respect, while authors in the field of computer mediated communications have pointed towards Giddens' theory of structuration.

I will argue in this chapter that both theories provide coherent theoretical frameworks with respect to the concepts and issues that I am interested in. Unfortunately, their theoretical frameworks are incompatible; that is, they are characterized by some non-trivial differences with regard to their respective theoretical solutions. This means that, eventually, I will have to choose which of the two approaches is the most suitable, or can be suitably modified in order to serve my purpose, which is to further both our understanding of the use and development of communication technologies, and our capacity to make practical contributions in relation to this.

Apart from evaluating the frameworks developed by Habermas and Giddens in terms of the criteria formulated at the outset, it may be useful to judge their appropriateness against the background of sociological insights that have emerged in the branches of sociology that are most closely related to my empirical domain, i.e. agrarian sociology and the sociology of rural development. Therefore, I will first discuss some of the recent findings and schools of thought in these closely related fields of study.

5.1 The (agrarian) sociology of rural development

In the context of the criteria formulated, there is little point in elaborating extensively on those approaches in this field of study that are clearly familiar to structuralism, functionalism or methodological individualism. More specifically, therefore, I will focus on the 'actor-oriented sociology of rural development' which is strongly inspired by the works of Norman Long (1977, 1989b, 1990, 1992). Moreover, Long has been an influential critic of extension theory and practice (Long & Van der Ploeg, 1989; Long, 1989a; Leeuwis, Long & Villarreal, 1990).

The actor/structure debate in the sociology of rural development

Given that much of the literature in the sociology of rural development refers to experiences within so called 'developing countries', it is hardly surprising that the two dominant approaches in this field have concentrated on the introduction of 'capitalist' relations of production in these regions. Whereas in *modernization* theory (e.g. Hoselitz, 1962) -the sociological pendant of economic growth theories (Rostow, 1962)- the expansion of commodity markets is essentially seen as a necessary and positive element in the process of evolution towards a technologically and institutionally advanced 'modern' society, neo-Marxist writers -for example *dependency* theorists like Wallerstein (1974), Amin (1974, 1976) and De Janvry (1981)- have stressed the adverse consequences and exploitative nature of such 'commoditization' processes, which -according to them- are inherently connected with the capitalist mode of production. Even if within the neo-Marxist tradition considerable attention is paid to the empirical diversity resulting from commoditization processes (see e.g. Friedmann, 1981; Bernstein, 1979, 1987; Gibbon & Neocosmos, 1985), this heterogeneity is predominantly explained in terms of historical or cultural conditions and/or other particularities, rather than deciphering it as an outcome of negotiation processes between actively strategizing, and knowledgeable actors (Long, 1986).

Despite the major ideological differences between (and even within) the two perspectives, Long concludes that "they share a common set of paradigmatic beliefs" in that both models "are tainted by determinist, linear and externalist views of social change" (Long, 1990:6).

Partly as a reaction to above mentioned approaches, and partly building on earlier anthropological perspectives, Long describes the emergence of so-called actor-oriented approaches within the sociology of rural development in the late 1960s and the early 1970s (1990:6-7; 1977:105-143). Within these approaches (such as the transactional approach (Barth, 1967), the decision-making approach (Ortiz, 1967; Moerman, 1968) and approaches originating from phenomenology and symbolic-interactionism) considerable interest existed in "explaining differential responses to similar structural circumstances" (Long, 1990:6). However:

> "In an attempt to combat simple structuralist views of social change, these studies concentrated upon the innovative behaviour of agricultural entrepreneurs and economic brokers, on individual decision-making processes or on the ways in which individuals mobilised resources through the building of social networks. Yet many such studies fell short because of a tendency to adopt a voluntaristic view of decision-making and transactional strategies which gave insufficient attention

> to examining how individual choices were shaped by larger frames of meaning and action (i.e. by cultural dispositions, or what Bourdieu (1981:305) calls *habitus* or 'embodied history', and by the distribution of power and resources in the wider arena). And some studies foundered by adopting an extreme form of methodological individualism that sought to explain social behaviour primarily in terms of individual motivations, intentions and interests" (Long, 1990:7, see for more elaboration Long, 1977:105-143).

Following Giddens, Long stresses the importance of the concept of 'agency' in overcoming the actor/structure dilemma. Giddens poses that the notion of action "is logically tied to that of power" (1976:10) in that it has an inherent transformative capacity. Agency then, according to Long (1989a:10):

> "attributes to the actor (individual or social group) the capacity to process social experience and to devise ways of coping with life, even under the most extreme conditions of coercion. (...) Agency - which we recognize when particular actions make a difference to a pre-existing state of affairs or course of events - is composed of social relations and can only become effective through them."

In order to avoid falling into the trap of voluntarism, Long, paraphrasing Marx (1973), urges us first to recall that even if actors all have power in the sense of agency, the circumstances in which they exert it are not simply of their own choosing (Long, 1990:8). To the same end he emphasizes that "agency is not simply an attribute of the individual actor" (1989a:10):

> "All societies contain within them a repertoire of different life styles, cultural forms and rationalities which members utilize in their search for order and meaning, and which they themselves play (wittingly or unwittingly) a part in affirming or restructuring. Hence the strategies and cultural constructions employed by individuals do not arise out of the blue but are drawn from a stock of available discourses (verbal and non-verbal) that are to some degree shared with other individuals, contemporaries and maybe predecessors. It is at this point that the individual is, as it were, transmuted metaphorically into the *social actor*, which signifies the fact that 'social actor' is a social construction rather than simply a synonym for the individual member of homo sapiens" (1990:9).[1]

Similarly, collectivities such as organizations could also be labelled as social actors, though - in order to avoid reification- it is important "to restrict the use of the term social actor only to those social entities that can meaningfully be attributed with power or agency" (Long, 1990:10). Implied by this second point is a third, which is that agency itself has a cultural dimension in the sense that what counts as 'knowledgeable' action, or as a 'capacity' (two terms central to Giddens' conceptualization of agency, see section 5.3), can vary among culturally distinct communities (Long, 1990:9).

Intermezzo: two bodies of empirical research

The empirical significance of the conceptualizations presented above (which lie at the root of what Long (1990:3) labels "an actor-oriented sociology of development") has been shown persuasively in at least two recent bodies of research which -although working with slightly different methodological tools- start from these, and are described below. The 'project' implied by the first body of research could be labelled *'the deconstruction of planned intervention'*, whereas the second can be described as *'farming styles research'*.

(1) In recent years a large number of case-studies have been published which focus on processes and day-to-day practices of planned intervention in agriculture (for example, De Valk & Sibanda, 1986; Arce & Long, 1987; Crehan & Von Oppen, 1988; Arce, 1989; Heijdra, 1989; Von der Lühe, 1991; Leeuwis & Arkesteyn, 1991; Van der Zaag, 1992; Brunt, 1992; De Vries, 1992). These case-studies show how the different actors involved in 'planned' intervention are actively strategizing and negotiating the outcomes of development projects, whereby the formal project plans are little more than just one of the elements in, and/or outcomes of, such inherently political processes. Hence, these case-studies paint a picture of the nature and usefulness of project plans and planning that contrasts sharply with the views of those who believe that such plans and planning are relatively efficient and unproblematic means to achieve certain previously defined goals and outcomes (see e.g. Van Dusseldorp, 1990). In theoretical terms, Long & Van der Ploeg (1989:228) draw the conclusion from these findings that:

> "the concept of intervention needs *deconstructing* so that we recognize it for what it fundamentally is, namely, an ongoing, socially-constructed and negotiated process, not simply the execution of an already-specified plan of action with expected outcomes"

As Crehan & Von Oppen (1988:113) put it:

> "[a] development project should be seen not simply in terms of its goals and their achievement or non-achievement, but rather as a social event, an arena of struggle between different groups with different interests".

More specifically, Long & Van der Ploeg criticize planned intervention models in that they tend to conceptualize "intervention as a discrete and clearly localized activity (i.e. as a 'project')", whereas both from an empirical and a theoretical point of view our understanding of intervention processes is enlarged considerably if we recognize that:

> "intervention never is a 'project' with sharp boundaries in time and space as defined by the institutional apparatus of the state or implementing agency. Interventions are always part of a chain or flow of events located within the broader framework of the activities of the state *and* the actions of different interest groups operative in civil society. Moreover interventions are linked to previous interventions (in policy models through 'evaluation studies'), have consequences for future ones, and more often than not are a focus for inter-institutional struggle or the arena where battles over perceived goals, administrative competencies, resource allocation and institutional boundaries are fought out" (1989:228).

Furthermore, they criticize what they call "the 'cargo' image of intervention" (1989:230), by which they refer to the visualization of intervention as an 'external' input, that somehow provides a 'break' or discontinuity with a previously existing state of affairs.

> "Linked to this 'cargo' image is the underlying belief that local situations, life-worlds or ways of organizing social life are no longer valid or somehow ill-founded and inappropriate, and hence need restructuring or perhaps even eliminating altogether, if development is to take place. The proposed 'cargo' is designed to resolve this by establishing new and more appropriate ways of doing things" (1989:231).

According to Long & Van der Ploeg, such a conceptualization disregards local knowledge and development capabilities, and fails to recognize that intervention entails not only the introduction of material and organizational inputs, but first and foremost the introduction of normatively based concepts, labels and criteria for defining problems, solutions and means, which may well be subject to a considerable amount of conflict and struggle as well (1989:232-233).

To the extent that external 'experts' (this time in 'local knowledge' or 'participation') are still assigned a crucial role in bringing about development, Long & Van der Ploeg maintain that these criticisms are also valid for approaches that stress the importance of participatory development and research (e.g. Chambers, 1983; Chambers et al., 1989; Richards, 1985).

(2) The second body of clearly discernable actor-oriented empirical material involves a number of studies across different sectors (arable farming, horticulture, dairy farming, cattle and sheep farming) and countries (Peru, Italy, Ireland and the Netherlands) on 'styles of farming' (e.g. Bolhuis & Van der Ploeg, 1985; Leeuwis, 1989; Roep et al., 1991; De Bruin & Van der Ploeg, 1991; Spaan & Van der Ploeg, 1992).

The primary focus within these studies is on heterogeneity in farming. Within them, one finds a strong focus on the identification of farming practices in the widest possible sense, their interrelations, and the evaluations, explanations, rationalizations and strategies that farmers express in relation to their own and other farmers' practices.

These studies show consistently that even among farmers operating in what appear at first sight to be comparable situations and 'structural' conditions, and not withstanding the operation of EC and agro-industry regulations and arrangements that might be expected to have homogenizing consequences, there is still a considerable -if not increasing (Van der Ploeg, 1990b)- diversity in patterns of farming. Following Hofstee (1985:227) these patterns of farming have been labelled 'farming styles'. While the classifications of farming styles in the earlier studies were predominantly empirically-based 'researcher constructs', an attempt is made in the later studies to generate taxonomies on the basis of local categorizations (see e.g. chapter 8).

Within such styles of farming, normative conceptions of what 'good' or 'proper' (family) farming is all about, emerged as important principles for the coordination of different practices in and through farm labour, or, in other words, for the coordination of different 'domains of farm labour' (i.e. the domains of production, reproduction, family & community, and the domain of economic and institutional arrangements; Van der Ploeg, 1991).

Styles of farming, then, can be described as sets of carefully coordinated strategies and practices with a normative dimension, which emerge as a particular patterns of labour organization, productive results, social and economic relationships, etc. Thus, such patterns reflect farmers' capacity to structure -at least to a certain extent- their own environment. Thereby, they can be seen as *strategic positions* vis-à-vis economic, technological and political developments (Van der Ploeg, 1990b:9), i.e. vis-à-vis what Benvenuti (1991a) has labelled the Technological-Administrative Task Environment of farming enterprises. Consequently, styles of farming are dynamic and change with alterations in the family, the community, and the economic, technological, ecological, administrative and political conditions.

Although 'external' factors are apparently important for understanding processes of agrarian change and diversity, Van der Ploeg (1990b:13, see also Long & Van der Ploeg, 1991:17) urges us to recognize that:

> "they are not relevant as 'ultimate causes'. Their relevance is to be located in the degree in which they figure as self-evident and internalized limits beyond which no action can be conceived or as imposed boundaries that are taken up as possible themes for negotiation, reconsideration, sabotage, and/or change, i.e. as "barriers that have to be moved" (Bourdieu, 1984:480)".

Not surprisingly, therefore, Van der Ploeg argues in relation to the commoditization debate that:

> "*markets* as such are not to be understood as 'causal' patterns explaining the particularity of farming", instead he argues that "*causal links themselves* are actively constructed in such a way that they fit with the given (or foreseen) styles of farming. (...) Social practice does not know a clearly distinguishable explanandum, nor a corresponding explanans. In farming at least the two fuse: a style of farming is, in the end, it's own explanans. It is a socially constructed *modus operandum*" (1990b:12).

The actor-oriented solution to the actor/structure debate continued, and criticized
Recently, Long & Van der Ploeg (1991) have, against the background of these empirical studies, attempted to develop an adequate conceptualization of structure. Building on earlier discussions of the concept by other scholars (e.g. Benvenuti, 1991a)[2], they argue that what is needed is "a definite *adieu* to structure understood as explanans", because:

> "Such a notion of structure amounts to nothing more than reification of what are considered to be 'central tendencies', and, as soon as heterogeneity is introduced into the analysis, this 'structural approach' withers away" (1991:21-22).

As an alternative, they characterize structure as:

> "an extremely fluid set of emergent properties, which on the one hand, results from the interlocking, and/or distantiation of various actors' projects, whilst, on the other hand, it functions as an important point of reference for the further elaboration, negotiation and confrontation of actors' projects. Understanding structure in this way, as the products of the ongoing interlocking, interplay, distantiation and mutual transformation of different actor's projects, is not to say that structure should be conceptualized simply as the aggregation of micro-episodes, situations or projects" (1991:22).

Although at first sight the conceptualization of 'structure' as "'differentiated' sets of emergent properties" (1991:24) resulting from 'interlocking projects' seems promising, I will make some objections to it, and point to certain inconsistencies in Long & Van der Ploeg's arguments as well.

(1) Although Long & Van der Ploeg recognize that structure is both a 'product' of, and a 'point of reference' for further (future) interlocking projects, they seem to overemphasize the former when they claim that "there is no structure external to social practices (i.e. outside the interlocking of projects) that explains these practices" (Long & Van der Ploeg,

1991:23), or that "a style of farming is, in the end, it's own explanans" (Van der Ploeg, 1990b:12; Long & Van der Ploeg, 1991:17).

By putting it so strongly they seem to disregard the historical and spatial dimensions of structure (i.e. interlocking projects), and in doing so they seem partly to contradict their earlier statement that action is shaped by 'embodied history' (Long: 1990:7) and that external factors may figure as "self-evident and internalized limits beyond which action is judged inconceivable" (Long & Van der Ploeg, 1991:17, see also Van der Ploeg, 1990b:13). Moreover, they seem to run counter to their simultaneous recognition of the validity of Marx's statements that actors operate under conditions that are not simply of their own choosing (Long & Van der Ploeg, 1991:6), and that actors often have "only a limited comprehension of the nature of the system as a whole" (Long & Van der Ploeg, 1991:22).

Although I agree that 'structure' does not exist behind the back of actors, it is clear that specific actors have to position their practices and projects against the background of not only their own previous or future practices and projects in time and space, but also vis-à-vis the practices and projects of other actors in time and space. That is, they also have to take the structures that others produce or have produced into account. Thus, it is clear that *outside* 'interlocking projects' there are other sets of 'interlocking projects', unless one wishes to argue (quite legitimately, but not very enlightening) that the world is one big set of interlocking projects, i.e. that 'everything is connected with everything'.

Clearly, the structures produced by means of other sets of interlocking projects are enabling and constraining, they may be subject to different interpretation, and they may or may not be consciously referred to in the production of action (see Long & Van der Ploeg, 1991:24-25); all of this taken into account, it cannot be denied that they may, at a particular point in time and in a specific context of interaction, be 'given' and out of reach of the actors involved.

Undoubtedly, Long & Van der Ploeg's conceptualization -which is at least in part correct- implies that such 'external' structures can have consequences only when they are in some way or another 'internalized' as 'self-evident boundaries/limits'. However, I would argue that this in fact supports rather than denies that 'external' structures (as perceived by actors, and to the extent that they are experienced as constraining and/or enabling) have a certain explanatory power. That is, to say that they have explanatory power only *through practice*, is not to say that they have *no* explanatory power. Of course, like Long & van der Ploeg, I am not talking about 'ultimate causes' or 'necessities' (who in this time of chaos-theory and statistical probability does?), but indeed about causalities that are actively moulded by actors, within a certain space for manoeuvre.

(2) A related problem is that Long & Van der Ploeg seem to stress the 'self-evident' character of boundaries and limits, which would imply that actors are either practically or discursively aware of the 'external' structures that they have internalized. By doing so this seems to assume through the back door a form of 'cognitive rationalism' of actors (in relation to their social environment), that seems to dissent with their earlier objection to rational decision-making models within the sociology of rural development.

(3) I believe that -even if they explicitly (1991:22) reject it- Long & Van der Ploeg's conceptualization of structure still leans towards seeing it as 'the simple aggregation of micro-episodes, situations or projects'. In order to transcend such a conceptualization it does,

in my view, not suffice to say that they are 'interlocked' and/or 'distantiated'. Rather, it is necessary to conceptualize *exactly how* micro-episodes, situations, projects or different sets of interlocked projects, are or are not connected. In my view, Long & Van de Ploeg fail to do so, so that their approach is characterized by conceptual omissions. Thus, contrary to their explicit purpose (1991:27, note 1), in the end Long & Van der Ploeg provide little more (if not less) insight into the precise relationship between actor and structure than Giddens does (1976, 1984). (Later in this chapter I will elaborate on my solution in this respect, i.e. an integration of Giddens' structuration theory with Knorr-Cetina's (1988) conceptualization of the relation between micro and macro-phenomena.)

(4) Long & Van der Ploeg's statement (following Darre, 1985) that "whenever such 'outside structures' are represented, we are simply confronted with reification and the possible camouflaging of particular social interest" (1991:23) makes sense. Given that in everyday life people (and also scientists) continuously use such reifications when explaining the practices and projects that they or others engage in, however, I think it is important to add that indirectly -and as a result of the double hermeneutic of social (including social scientific) knowledge (Giddens, 1976:158)- reified explanations may indeed have a certain validity.

(5) To say that structure is "an extremely fluid set of emergent properties" (Long & Van der Ploeg, 1991:22) again seems not very helpful in explaining why, in the experience of many people, certain 'emergent properties' (as perceived by these actors), or 'boundaries/limits beyond which action is judged inconceivable', are very persistent and require hard struggle in order to be changed. Despite the active and diverse practices and projects of for example farmers, and despite the different and changing perceptions or even nature of emergent properties, it would be hard to deny that there is not something like a continuous exodus of farmers in Western agriculture, that relationships between the North and the South tend to be imbalanced, that ideologies, scientific paradigms, or intervention models and practices are not easily eradicated, etc.

One could probably safely say that it is exactly such 'persistent emergent properties' that authors like Long and Van der Ploeg (and many others) are trying to fight. Thus, I suspect that there may be an inconsistency between *what* Long & Van der Ploeg say, and *why* they say it.

(6) Long's treatment of collectivities as social actors, and his warning "to restrict the use of the term social actor only to those social entities that can meaningfully be attributed with power or agency" (Long, 1990:10), seems somewhat superfluous and obscuring. If individuals are social actors in that they have to be seen as constituted by the multiplicity of networks in which they take part, why do we need a special treatment for actors that take part in networks that are labelled as 'organization' or 'institution'?

In short, I have the feeling that especially the concept of structure within the actor-oriented sociology of rural development needs further development. With the present conceptualization we run the risk of trading in 'individual voluntarism' for 'actor voluntarism'.

Knowledge, information, ignorance and communication from an actor-oriented perspective

Where extension scientists tend to make a sharp distinction between knowledge and information, actor-oriented sociologists tend to reject this separation:

> "Both are in fact elements of a single interpretative process, since information has no meaning if it cannot be internalized, and by being internalized, it becomes part of a stock of knowledge. It is not helpful therefore to dichotomize the two" (Leeuwis, Long & Villarreal, 1990:20).

Arce & Long (1987:5) describe knowledge as "constituted by the ways individual members of a society or social group categorize, code, process and impute meaning to their experiences". According to them, knowledge is embedded in actor's 'life-worlds', and thus the understanding of knowledge processes "must therefore be situated in terms of the 'life-worlds' of those individuals and groups affected" (1987:5).

> "The concept of life-worlds derives from Schutz and implies simultaneously both action and meaning. It is a 'lived-in and largely taken-for-granted world' (Schutz and Luckmann, 1974). It is constituted of various forms of social knowledge, intentions and evaluative modes, and types of discourse and social action, through which actors attempt to order their worlds. Such life-worlds are the products of past experiences and personal and shared understandings, and are continuously reshaped by new encounters with people and things. Although the researcher attempts to come to understand the make-up of different life-worlds, they are essentially actor rather than observer defined" (Leeuwis, Long & Villarreal, 1990:26, note 3).

In contrast to the emphasis on the individual-cognitive aspect of knowledge and information that is dominant in most fields of study discussed in the chapters 3 and 4, actor-oriented sociologists (Arce & Long, 1987; Long, 1989; Leeuwis, Long & Villarreal, 1990) tend to stress the social dimensions of the life-world:

> "knowledge processes are embedded in social processes that involve aspects of power, authority, and legitimation; and they are as likely to reflect and contribute to conflict among social groups as they are to lead to the establishment of common perceptions and interests" (Leeuwis, Long & Villarreal, 1990: 20-21).

Interestingly, this conceptualization leads sociologists to simultaneously associate the (social) construction of knowledge with the (equally social) production of *ignorance*:

> "a body of knowledge is constructive in the sense that it is the result of a great number of decisions and selective incorporations of previous ideas, beliefs and images, but at the same time *destructive* [emphasis CL] of other possible frames of conceptualization and understanding. Thus it is not an accumulation of facts but involves ways of construing the world" (Arce & Long, 1987:5).

The creation of knowledge in relation to the generation of "systematic forms of ignorance" (Arce & Long, 1987:27) has been documented especially in the context of intervention processes (Arce & Long, 1987; Quarles van Ufford, 1990; Leeuwis, 1989), and implies a rather different way of looking at the relation between knowledge and ignorance than that implicit in many branches of e.g. extension science. The latter tend to mainly focus on knowledge as something that *alleviates* ignorance, i.e. as a phenomenon that tends to produce 'enlightenment'.

Although within the actor-oriented sociology of rural development there is little explicit attention to theorizing about 'communication', it is clear that looking at knowledge as a socially constructed phenomenon has implications for its conceptualization. The limited interest in communication as such can be safely attributed to the idea that an actor-oriented perspective implies that it is not very useful to single out the communicative aspect of social interaction, since the meaning of what is being communicated cannot be understood without taking other dimensions (such as ideological, normative and political aspects) into account.

It is this basic understanding that lies at the heart of the criticism towards those (including many extension scientists) who tend to single out the communicative aspect. In addressing extension scientists, for example, Long (1989a) criticizes Havelock (1986b) and Röling (1988b) for the mechanistic implications of their conceptualization of communication and linkage, and argues that -in communication processes- knowledge and information are not simply transported, but jointly created in an inherently social process of "fusion of horizons" (1989a:3-4).

Different types of knowledge and rationality

An issue that has received considerable attention in both the sociology of rural development and extension science are the differences between, and/or the relative importance of, scientific knowledge (or episteme, formalized knowledge, etc.) versus various forms of non-scientific knowledge (or techne, indigenous knowledge, local knowledge, l'art de la localité, etc.)[3] (see Marglin, 1991a, 1991b; Benvenuti, 1991b; Warren, 1991; Chambers, 1983; Richards, 1985, 1991; Mendras, 1970; Van der Ploeg, 1987; Frouws & Van der Ploeg, 1988; Röling, 1988).

Some authors in this debate have stressed the fundamentally different character of different types of knowledge. Marglin (1991b), for example, argues that 'episteme' and 'techne' are "distinct ways of understanding, perceiving, apprehending and experiencing reality", whereby even if in practice the two are symbiotic, "Western culture has elevated *episteme* to a superior position, sometimes to the point that *techne* is not only regarded as inferior, but as no knowledge at all" (1991b:112).

Episteme and techne, according to Marglin, are different "knowledge systems" defined "by a series of binary oppositions on the axis of epistemology, transmission, innovation and power" (1991b:113). At the epistemological level, 'episteme' is described as logically deduced, analytic, articulate, cerebral, theoretical, geared to verification, impersonal, impartial and presumably universal, while 'techne' is labelled as based on authority or intuition, experiential, indecomposable, implicit, tactile, emotional, pluralistic, personal and contextual (1991b:113-115). Furthermore, Marglin suggests that episteme is generally acquired through formal schooling, while techne is transmitted and absorbed in a rather unconscious manner in the context of an hierarchical master-apprentice relationship (1991b:116). Similarly, innovation in the episteme implies challenging and criticising earlier models, while innovation in the techne is better characterized as commenting upon, and reinterpreting them. Finally, Marglin argues that episteme and techne are characterized by different power relations; while episteme assumes a (scientific) "community of equals", techne is associated with a "hierarchy of power within the knowledge community" (Marglin, 1991b:116).

In Marglin's view 'episteme' is closely associated with Western science, while 'techne' is expressed as 'indigenous technical knowledge'. From an actor-oriented perspective, however, such sharp distinctions between scientific and non-scientific knowledge cannot be considered very helpful. Not only can it be shown that, in time and space, non-scientific knowledge can include all sorts of (more or less adapted) scientific elements (and vice versa), but -at the theoretical level- it can be argued as well that, in essence, the production of scientific knowledge is as much a social process as is the production of non-scientific knowledge. Knorr-Cetina (1981) and others (Lynch, 1985; Latour, 1987), for example, have shown persuasively that even in a scientific laboratory the production of knowledge is inherently connected with (speaking in Marglin's terms) authority, intuition, hierarchy, personal and other 'techne-like' aspects. Thus, Knorr-Cetina argues that scientific knowledge too is of a contextual and 'local' nature (1981:152).

The implication of Knorr-Cetina's position for agrarian science is close to what Van der Ploeg (1987:316) (paraphrasing Feyerabend, 1975) labels the 'anarchistic' thesis of the agrarian sciences:

> "In such a perspective (agrarian) science can be conceptualized as a local system of knowledge, that in principle has no superiority over other local systems of knowledge (such as those of farmers)." (transl. CL)

A slightly less radical vision on the agrarian sciences -which Van der Ploeg presents as a competing interpretation- is labelled as 'relativistic rationalism', whereby the agrarian sciences are seen as:

> "in principle a knowledge system of a different kind, that can -in certain respects- overcome and/or supplement current local knowledge systems. Science [in this view] has certain inherent abilities (i.e. the ability to systematically and critically reflect on its own foundations, methods, goals and results), by means of which local knowledge can indeed be enriched" (1987:317).

In my view, the two perspectives are hardly conflictive; in both views it seems impossible for science to unproblematically claim superiority or universality, while the 'anarchistic' view certainly does not exclude the possibility that the local knowledge system of agrarian science can -on the basis of its specific cultural characteristics- generate insights that can enrich other local knowledge systems.

It must be noted, however, that most obviously in the 'anarchistic' view, Van der Ploeg's (1987) and Frouws & van der Ploeg's differentiation (following Mendras, 1970) between 'l'art de la localité' (specific farmers' knowledge that arises from the interaction between manual and intellectual labour in the farmer's labour process) and scientific knowledge becomes confusing -if not misleading- as soon as one recognizes the local dimensions of agrarian science, since it means that scientists' knowledge too probably includes elements of an 'art of the specific'. Hence, the process of 'scientification' in (primary) agriculture (described by Van der Ploeg (1987:111; transl. CL) as: "the continuing reorganization of the farm labour process towards the design that is developed in science") might be more precisely described as a historical process whereby elements of one type of contextual knowledge (l'art de la localité of scientists) have become increasingly incorporated into farmers' labour processes, and thereby into farmers' l'art de la localité.

The phenomenon, then, that the contemporary agrarian sciences (in contrast to its predecessor 'agronomy') are indeed increasingly preoccupied with the design of normative models of how farming *ought to be* (re-)organized (Long & Van der Ploeg, 1991:17) rather than studying the empirical diversity of how farming *is* organized, is -at present- indeed a socially constructed 'emergent property' of mainstream agrarian science, but not a necessary characteristic of science as such.

As Benvenuti (1991b) points out, this normative and unilinear turn in (agrarian) science is closely connected with the (by no means a-political) shift in popularity among scientists of formal knowledge at the expense of non-formal knowledge:

> "The explosion of popularity of formalization techniques in all sorts of pure and applied scientific research can be basically explained by the fact that, first, formalization imparts a definite shape to phenomena otherwise difficult to delimit or perceive -it makes them *discrete*; then it renders *computable* growing sectors of the world; third, it enhances *consistency* of the scientific products (material as well as mental). Therewith the possibility of scientifically producing future truths has made a leap forward. And thereby the Universe seems to be increasingly acquiring the features of being or becoming *a program.* (...) In the end, formal knowledge means *reducing continuity to discretion* and having finally a *computational perspective* emerge in science owing to the "algorithmic compressibility" of the world" (Benvenuti, 1991b:39).[4]

Clearly, the increasing formalization of knowledge in the agrarian sciences, and the type of scientification that arises from this, reflects a type of thinking that I have earlier described as 'hard' systems thinking. In this view, the natural and the social world are essentially seen as predictable, controllable and therefore optimizable towards a previously defined goal. I have already shown that such a model starts from a utilitarian (Weberian) conceptualization of rationality, and goes along with the type of passive conceptualization of human action that is rejected within an actor-oriented sociology.

Although the concept of 'rationality' has so far not received a great deal of attention in the actor-oriented sociology of rural development, actor-oriented studies show consistently that different actors have different ways of rationalizing their activities, and that such 'rationalities' are crucially connected with actor's agency and the social context in which they interact. For example, the existence of different farming styles reflects the operation of different normatively-based rationalities in coordinating the different domains of farm labour. Thus, like knowledge, it can be argued that rationality too must be looked at as a cultural and socially-constructed phenomenon.

Communication technologies from an actor-oriented perspective

In agrarian sociology several studies have been carried out that aim to make both an inventory of the introduction of process and management automation in agriculture, and a critical evaluation of the (expected) impact on labour conditions, the quality of labour, employment in agriculture, etc. (e.g. Van Tilburg & Nigten, 1987; Nigten, 1987a, 1987b; Overbeek & Munters, 1988). The studies mentioned were carried out at request of trade unions and young farmers associations, and therefore tend to be of a policy-oriented nature. Not surprisingly, more theoretically inspired critiques on the introduction of communication technologies are connected with the debates on the formalization of knowledge, and the specific type of scientification that arises from this (Frouws & Van der Ploeg, 1988; Benvenuti, 1991b).

Frouws & Van der Ploeg (1988:44) conclude that the use of communication technologies cannot be explained from the slogans with the help of which diffusion is stimulated (i.e. fine-tuning, reduction of production costs, reducing lack of freedom and spare time) since, in practice, these 'promises' have not materialized. Instead, they show how the actual use of communication technologies supports further scale enlargement and standardization of farming practice; that is, present-day communication technologies "carry in them the code of the dominant agricultural model" (1988:88, transl. CL). This model, according to them, is not only inherently linked with the scientification of agriculture (i.e the normative design developed by mainstream agrarian science) but has also become increasingly outdated and irrational in the context of the problems facing the agricultural sector in the Netherlands (1988:85).

Furthermore, they argue that communication technologies "slavishly follow familiar tracks" (1988:84, transl. CL) and are not applied in a very creative manner; that is, they concentrate at supporting and/or automating processes, tasks and procedures that farmers had already managed to control satisfactorily anyway (1988:84-85). In many ways, they argue, the adoption of communication technologies by farmers can be understood with reference to the fairy tale of the "emperor without clothing", whereby the farmers are the good and obedient citizens who welcome the emperor without clothing in order to avoid sanctions (i.e. to be seen as a 'bad' citizen) (1988:78-79).

Even if Frouws & Van der Ploeg present their conclusions in a rather polemical manner, the essence of their argument cannot be disregarded easily, for their conclusions with regard to the inherent code in communication technologies, the lack of creativity, and the importance of ideology, have since been confirmed in more systematic empirical enquiries (Kruiter & Langen, 1988; Van Dijk et al., 1991; Roep et al., 1990).

At the more fundamental level, Frouws & Van der Ploeg (1988:30,54) argue that there is an inherent connection between communication technologies and scientific knowledge in that computers presuppose scientific knowledge. According to them, farmers' knowledge or l'art de la localité has a "different cognitive-normative structure" which makes it unsuitable for including it in a communication technology. Furthermore, they illustrate how efforts to transform l'art de la localité into scientific knowledge by means of the Delphi-method (Van Houten, 1989) have proved to be difficult (1988:59). According to them, this incompatibility -if not recognized- can lead to all sorts of problems with regard to the practical usefulness of communication technologies.

I have argued already that making such a fundamental distinction between scientific and other forms of knowledge is questionable. Moreover, as for example Benvenuti (1991b) recognizes, present-day software techniques (especially artificial intelligence techniques) allow indeed for the integration of rather non-formal types of knowledge -such as rules of thumb- in computer programs. This is not to deny that in practice such an integration of non-formal knowledge in agricultural communication technologies is yet to be observed, nor that one can seriously question the possibility and/or usefulness of generalizing rules of thumb from one context to another. Nevertheless, Frouws & van der Ploeg's point of view in this respect cannot at the theoretical level be maintained when starting from an actor-oriented perspective.

In section 4.2, I concluded that extension science provides us with a fairly illuminating framework for describing several types of anticipation problems, but that it has little to offer in understanding how and why these anticipation problems come about. In fact, although in other terms, Frouws & Van der Ploeg also describe a number of anticipation problems which, according to them, are mainly caused and reproduced by the nature of agrarian interest intermediation in the Netherlands:

> "The systematic de-politization of past and future choices, the systematic definition of agrarian interest and technological development as being neutral, the complete identification with the central lines of the dominant agricultural model, and the sometimes suffocating inclination for unanimity - all these crucial characteristics of the agrarian corporatism impede a use of information technology that transcends present-day automation" (1988:101; transl. CL).

Even if they thus make clear that anticipation problems have political and ideological dimensions, Frouws & Van der Ploeg's explanation seems rather general and even somewhat structuralist in nature. At least their book fails to give a detailed insight into the actors, day-to-day practices and agency involved in the shaping of CT-characteristics. Nevertheless, although an actor-oriented sociology of rural development has not as yet explored this ground, it has indeed a potential to do so. In order to further our understanding of anticipation problems, it may -in line with the empirical studies on 'the deconstruction of planned intervention'- be fruitful to study the day-to-day practices of communication technology development, which -not unlike (technology) development efforts in 'developing countries'- are predominantly taking place in the context of (state-)subsidized projects that increasingly include a certain amount of 'user-participation'. Similarly, our insight may be considerably improved by studying diversity in farming (i.e. farming styles) in relation to possibly different patterns of communication practices, information needs, and communication technology use.

Although an actor-oriented approach may indeed help to improve our understanding of anticipation problems, it is less clear if and how it will improve our capacity to practically intervene. Although I do not agree with simplistic distinctions between 'knowledge for action' and 'knowledge for understanding', I think that authors (e.g. Van Dusseldorp, 1990; Hulme, 1990; Röling & Engel, 1990) who question the practical relevance of an actor approach have a point to make in the sense that actor-oriented sociologists have not sufficiently reflected on their own role as social actors in shaping particular social outcomes. Until now, for example, Long & Van der Ploeg have not redeemed their promise (1989:242) to elaborate on the practical implications of their theoretical critique of planned intervention. Therefore, the critics' argument that an actor approach can be nicely used to show and understand retrospectively what went wrong, but that it does not provide those whose job it is to intervene with sufficient tools and means to improve prospectively their performance, seems indeed to gain strength.

Conclusion

In sum, an actor-oriented sociology of rural development provides: (a) some relevant empirical insights in relation to planned intervention and diversity; (b) conceptualizations of actors, action, knowledge (and ignorance!) and information that are promising in that they meet the criteria formulated at the outset; and (c) methodological guidelines for conducting empirical studies aimed at improving the understanding of anticipation problems (see for details section 6.3).

Given its rather limited systematic attention to practical issues, it also provides a challenge to translate the actor approach into a to workable 'tool' or method that can be used to improve intervention in general, and intervention in relation to communication technologies in particular.

At the theoretical level, however, there are also some inconsistencies, omissions and problems, especially related to the conceptualization of structure. Although the actor-oriented approach indeed generates a number of seemingly important "guiding analytical concepts" such as: agency, social actor, 'multiple realities', arena's of struggle, life-worlds, discourses, interfaces, discontinuities of interest, values, knowledge, power, structural heterogeneity, strategies, interlocking projects, organizational fields, networks of knowledge and power, and processes of negotiation and accommodation (Long & Van der Ploeg, 1991:25-26), it is not always clear exactly how these are theoretically connected to each other. Furthermore, some concepts that I have deemed important in relation to this study (i.e. communication, social norms, ideology) are not explicitly dealt with. Moreover, as some critics have argued (e.g. Schrijvers, 1992; Röling, pers. comm.), the actor approach provides a better language for dealing with struggles and conflicts that emerge at particular social interfaces[5], than with the cooperation, accommodation, and collective agency which is also implicit to such interface situations. Clearly, the understanding of these latter phenomena too is crucial for achieving non-accidental social change.

In all, there is a need to look for more comprehensive and overarching frameworks in general sociology that can help to connect logically these concepts in a way that does not jeopardize the basic starting points of the actor-oriented approach.

5.2 Extension and Habermas' theory of communicative action

In the recent past extension and extension science have been critically evaluated from a Habermasian perspective (Koningsveld, 1980, 1990a, 1990b; Pijnenburg, 1991). In terms of Habermas' distinction between instrumental, strategic and communicative action (see section 3.3), both the theory and practice of extension have been discredited for their instrumental and/or (latent) strategic implications. These criticisms have been effective in the sense that extension scientists have recognized the problems raised by Habermasian philosophers, and are actively struggling to come to grips with these. As a result some of them are suggesting to fit elements of Habermas' theory in an alternative theoretical basis for extension science (Röling, 1992; Engel, forthcoming; Dissanayake, 1991; Bawden & Macadam, 1991). Apparently, Habermas' theory does not only provide a framework through which extension and extension science can be effectively criticized, but it also offers a number of appealing concepts and ideas with the help of which extension scientists hope to both develop a more adequate theoretical understanding of, and attain greater legitimacy for, extension processes and activities in 'multi-actor' contexts (see section 4.2).

In order to evaluate the prospects of Habermas' framework in terms of the criteria formulated, I have to elaborate briefly on it. Given the extremely wide coverage and complexity of Habermas' work, I will limit myself to the most important elements in relation to my field of interest.

Habermas (1981a:384) distinguishes between instrumental action (instrumentelles Handeln), strategic action (strategisches Handeln) and communicative action (kommunikatives Handeln). Instrumental action, according to Habermas, is behaviour which involves the following of technical prescriptions -based on nomological knowledge[6]- in order to achieve certain previously defined goals (Habermas, 1981:385). Strategic action is still oriented towards the realization of specific goals, but the actor recognizes other actors as equally strategic opponents, rather than as 'objects' that obey certain nomological rules. Finally, a third type of social action[7] is labelled communicative action, of which Habermas speaks when actors aim at reaching agreement or consensus on a common definition of the situation (Verständigung) as a basis for coordinating their activities. Thus, this type of action distinguishes itself from instrumental and strategic action in that the coordination of action does not arise from egocentric goal-oriented 'calculation' (egozentrische Erfolgskalküle) by self-interested actors (1981a:385).

As I will show below, Habermas' classification of action is closely connected with his theoretical understanding of: (a) rationality; (b) communication; (c) knowledge; and (d) the relation between human action and structure.

Habermas and rationality

Habermas directly links his theory of communicative action with a theory of rationality, since -according to him- the reaching of consensus by means of communicative exchanges clearly presumes a different way of reasoning than is involved in instrumental and strategic action.

According to Habermas (1981a:27), evaluating the rationality of an act or utterance implies criticizing the grounds or reasons (i.e. the knowledge or validity claims) on which the particular utterance was based. In the case of a *cognitive-instrumental rationality*, Habermas proposes that such a criticizing process takes place on the basis of knowledge of the objective (material and/or social) world; that is, on the basis of nomological knowledge[8].

Testing the rationality of an utterance in the communicative sense, however, does not only involve evaluations on the basis of nomological knowledge of the 'objective world'. As we have seen, communicative action requires the creation of consensus on a common definition of a situation. Such a common situation definition -according to Habermas- has three dimensions, and a shared interpretation concerning the 'objective world' is only one of them. A common definition of a situation definition also has a subjective dimension, which refers to the shared understanding by actors of each others wishes and feelings (Koningsveld & Mertens, 1986:83), and a social dimension, which involves a normative agreement on the nature and legitimacy of the interpersonal relationships involved (Koningsveld & Mertens, 1986:84). Thus, *communicative rationality* implies both cognitive-instrumental rationality at the objective level, and what Habermas calls moral-practical rationality and aesthetic-practical rationality at the social and the subjective level respectively (Habermas, 1981a:326)[9].

In relation to this, Habermas suggests a procedural conceptualization of communicative rationality; that is, he proposes that the communicative rationality of certain outcomes is to be evaluated in terms of the conditions under which the actors involved are able to reach consensus on what is to be perceived as the (objective, subjective and social) 'reality'.

A crucial element in such a process of reaching agreement is argumentation; that is, criticizing the objective, subjective and social validity claims that are made[10]. Habermas views an act or outcome as communicatively rational when it emerges in or from a situation in which actors can freely engage in such a process of argumentation. Such a situation is labelled an 'ideal speech situation' in which undistorted communication can take place (Habermas, 1970a, 1970b, 1981a). In such a situation conflicting situation-definitions (amongst others on the basis of diverging interests) can be solved by the "peculiarly unforced force of the better argument" (Habermas, 1973:240).

As I have shown in previous chapters, this focus on reaching consensus by means of argumentation and critique is appealing to both extension scientists of several convictions and soft systems thinkers, in that it offers them arguments to stress the theoretical importance and legitimacy of a role for extension agents in facilitating communicative rationality. I will show in the next section that the need for such facilitators in modern society can indeed be grounded in Habermas' conceptual framework.

Habermas and the relation between action and structure

The relation between action and structure is tackled by Habermas in the sense that he explicitly tries to come to an integration of action-theory (Handlungstheorie) and system-theory (Systemtheorie) (Habermas, 1981b:173). He does so by linking his classification of action to different societal realms, and discussing the interrelations between the two.

Society, according to Habermas, can be simultaneously conceptualized as system (System) and life-world (Lebenswelt) (1981b:180). Focusing on the system aspect of societies means highlighting their institutional (political and economic) organization, while focusing on the life-world aspect means centring upon the whole of culturally transmitted frames of interpretation, which form an (initially) unproblematic background against which actors create situation definitions (Kunneman on Habermas, 1983:101).

In modern society[11], the system is constituted by the economy and the state, and the coordination of (political and economic) activities therein is mediated by *power* and *money* (empirical coordination by means of *entsprachlichte Kommunikationsmedien*, resulting in system-integration). The actions within the system are predominantly of an instrumental and/or strategic nature, and guided by cognitive-instrumental rationality. The life-world can be subdivided into a private and a public domain, reflecting different levels of social communities[12]. In these communities activities are coordinated by means of the use of *sprachliche Verständigung* (communicative coordination resulting in social integration). Thus, the dominant form of action in the life-world is communicative action as inherently connected with communicative rationality.

Historically, the disconnection between the system and the life-world went along with the emergence of formally regulated (that is, institutionalized by means of law) exchange relationships between the two. According to Habermas (and building on Marx) there are four types of exchange relationships between the system and the life-world.

Between the economic system and the private domain, labour is exchanged for wages, while goods and services are exchanged on the basis of economic demand. Between the state and the public domain, taxes are exchanged for administrative services, while political decisions can be taken in exchange for a certain amount of mass-loyalty. These relations, according to Habermas all involve power and money as (communication)media for interaction, and therefore he speaks of their monetarization and bureaucratization (1981b:477). This mediatization (Mediatisierung) of the life-world in modern society has thereby (even if this is not a necessary result) turned into a *colonization* of the life-world by the system (1981b:452,471). By this, Habermas refers to the phenomenon that working in the formal organizations of the system encourages a utilitarian (cognitive-instrumental) attitude towards the self and other people, which can be accompanied by a rather expressive and hedonistic lifestyle (Kunneman on Habermas, 1983:133). Thus, the term 'colonization of the life-world' reflects the strengthening of cognitive-instrumental and aesthetic-practical rationality within the life-world, at the expense of moral-practical rationality, and therefore an erosion of communicative rationality.

It is this colonization process (and not so much the differentiation between system and life-world per se) which, according to Habermas, leads to adverse societal consequences in that power and money interfere with certain societal problems (e.g. problems of emancipation, environmental degradation, war, etc.) that can only be adequately solved by means of communicative action. Thus, Habermas' framework can be seen as a strong plea for a restoration of normative controls from the life-world on political and economic decision making, at the expense of the narrow cognitive-instrumental rationality that aggravates or causes certain problems rather than that it solves them.

Legitimizing communicative intervention

Even if Habermas' integration of action theories and system theories may not provide the clear understanding of the relation between action and structure that I am seeking (see the final discussion of the prospect of Habermas' theory), it does provide extension scientists with an attractive framework for analyzing and legitimizing extension processes.

In Habermas' terms, we have seen that the scope for communicative rationality is threatened on the one hand by the disconnection between the system and the life-world, and on the other by the colonization of the life-world, whereas at the same time (and paradoxically), the theoretical possibility for communicative rationality is increasing in the sense that an increasingly differentiated and sophisticated body of knowledge is emerging as a result of the very same process of social evolution[13].

In fact, the increase of critical potential in social evolution leads to a possible 'overloading' of communicative action (Kommunikationsaufwand) (Habermas, 1981b:269). In principle, this pressure can be relieved in two ways. First, the coordination of activities on the basis of consensus on a situation definition (arrived at by means of 'sprachliche Verständigung') can be replaced by a coordination that is mediated with the help of money and power (entsprachlichte Kommunikationsmedien) (1981b:269-270); that is, it can be removed from the realm of the life-world to the system. Secondly, it can be 'condensed' with the help of communication technologies and mass media, which implies a shift from the private to the public domain in the life-world (1981b:270,274). The time and space barriers that are overcome by means of such communication technologies have as a consequence that the validity claims made in these communicative interactions cannot be immediately criticised, and therefore that the immediate outcomes cannot be unproblematically called communicatively rational. However, Habermas maintains that in principle the contents (validity claims) communicated through such communication technologies can be rationally evaluated in the sense that the extent to which they are to be trusted can be rationally motivated, even if this (dis)trust cannot be immediately tested (Habermas, 1981b:270,274; Kunneman, 1983:111).

Apparently, Habermas sees a legitimate and positive (although not unproblematic) role for the use of mass media and communication technologies as a means to secure communicative rationality and prevent and/or combat the increase of cognitive-instrumental rationality, i.e. the colonization of the life-world. This, of course, is good news for professional communicators (including extension agents), and those who make it their job to study communicative intervention (e.g. extension scientists).

Following a similar line of reasoning, Pijnenburg (1991:129) proposes a -from a Habermasian perspective- more legitimate conceptualization of extension than is implied by the definitions by Van den Ban, Röling and Van Woerkum that were presented in chapter 4. According to him, extension could be legitimately seen as "a secondary social-integrative medium with the function to bridge the gap between different [structurally differentiated[14]] knowledge and action practices, by means of an optimization of the conditions under which opinion formation and decision-making processes can take place in a [communicatively] rational manner" (Pijnenburg, 1991:129; transl. CL).

As we have seen, some KIS adepts increasingly accept such a normative definition of extension, while PI authors (in Habermas' terms) tend to embrace the colonization of the life-world as an empirical reality, and show a great concern for adequately balancing communicative, instrumental and strategic interventions. In relation to communicative interventions they share Habermas' focus on argumentation, but in arguing that arguments should be based on 'empirical evidence' they tend to single out cognitive-instrumental rationality as the dominant type of rationality, and exclude (in the context of extension interactions) the possibility to engage in other types of discourse and critique (such as practical discourse on normative rightness) than theoretical discourse on nomological propositions. At the same time, however, they consider the possibility to strategically use normative and emotional 'tactics' in order to support cognitive-instrumental rationality.

Habermas and communication

Communication is the central concept in Habermas' framework, and Habermas' conceptualization of it is much more 'social' than the ones elucidated in previous chapters, in that Habermas links communication explicitly with normative issues and power.

Communication, in Habermas' terms, is all about the coordination of human activities. Habermas' distinction between instrumental/strategic and communicative action (and the different types of rationality that are inherent to these) logically implies the existence of different types of coordination and therefore communication. Communication can be either mediated by money and power (entsprachlichte Kommunikationsmedien), which Habermas calls 'empirical coordination', or by means of reaching consensus on a situation definition (sprachliche Verständigung), which he labels 'communicative coordination' (Habermas, 1981b:269-270).

The distinction between non-linguistic (entsprachlichte) and linguistic (sprachliche) media, does not imply that language does not play a role in the coordination of instrumental/strategic action, but rather that it plays a different role than in communicative action. In order to clarify this, he develops a classification of speech acts which corresponds with his idea that each speech act implies an objective, a social and a subjective validity claim (concerning 'truth', 'normative rightness' and 'authenticity' respectively). In the main text I will not elaborate on this classification[15/16/17]. Suffice it to say that studying communication processes from a Habermasian point of view might fruitfully involve the analysis of speech acts. In the context of communication technologies, this raises a number of intriguing questions in relation to the validity claims inherent in CT, the extent to which they can be criticized, the interaction between the use of natural language in software packages (i.e. in the user-interface) and the different levels of formal 'languages' inherent in these (programming languages, machine code, compiler language, etc.)

Habermas, knowledge and information

The foregoing reflects Habermas' recent attempts to ground a new variant of critical theory (building on earlier versions of the Frankfurter Schule) on the theory of communication and language. In his earlier work, however, his endeavours in grounding critical theory focused on the theory of knowledge, and, as Giddens (1987) points out, it is not very clear if, and to what extent, Habermas has indeed moved away from his earlier elaborations on knowledge. For the moment, therefore, I will mostly base my account of Habermas' conceptualization of knowledge on his earlier work, most notably his inaugural address 'Erkenntnis und Interesse' (1965; Engl. transl. 1971).

In 'Knowledge and human interest' Habermas (following Horkheimer, 1977) rejects claims that purely objective theoretical knowledge exists which is disconnected from societal interests. According to Habermas, both the empirical-analytical sciences with their focus on nomological knowledge, and the historical-hermeneutic sciences with their focus on 'Verstehen', have fallen in the trap of positivism, in that both claim the existence of a value-free and thereby 'universal' knowledge[18] (Habermas, 1971:303). Habermas argues that it is insufficiently recognized that both types of theoretical knowledge can be traced back to a pre-scientific understanding (Vorverständnis); that is, the meaning of theoretical statements, and the effort of generating them, can only be understood from a previously existing interpretative framework (1971:304-310).

The foregoing implies, according to Habermas, that knowledge is inherently connected with interests, of which he distinguishes three types. First, the empirical-analytical sciences are characterized by an interest in *technical* control of causal relationships on the basis of nomological knowledge. Such knowledge is by no means objective or neutral since it is inherently linked with instrumental action and interests in the non-scientific world (Habermas, 1971:308-309). Second, the historical-hermeneutic sciences are typified by a *practical* interest in improving consensus among actors on the basis of the understanding of meaning (Sinnverstehen), whereby "the systematic sciences of social action" (i.e. political science, economics and sociology) are equally interested in the production of nomological knowledge (1971:310).

The critical social science that Habermas eventually promotes as an alternative, is shaped by an *emancipatory* interest which aims at criticizing nomological knowledge claims by investigating:

> "when theoretical statements grasp invariant regularities of social action as such and when they express ideologically frozen relations of dependence that can in principle be transformed" (Habermas, 1971:310).

A crucial element for such a critique of ideology is methodical self-reflection on the side of those that the law-like regularities are about.

> "Thus the level of unreflected consciousness, which is one of the initial conditions of such laws, can be transformed. Of course, to this end a critically mediated knowledge of laws cannot through reflection alone render a law in itself inoperative, but it can render it inapplicable" (1971:310).

Parallel to his distinction between the three knowledge-constitutive interests, Habermas discriminates between three types of knowledge:

> "*information* that expands our power of technical control; *interpretations* that make possible the orientation of action within common traditions; and *analysis* that free consciousness from its dependence on hypostatized power" (1971:313, emphasis CL).

He continues to describe these interests and the corresponding types of knowledge as being rooted in different "means of social organization"; that is, work, language and power: "knowledge-constitutive interests take form in the medium of work, language and power" (1971:113). Here we already see a close link with Habermas' later distinction between different media for communication (money, 'sprachliche Verständigung' and power), and their connection with distinct societal realms (the economy (system), the life-world, and the state (system) respectively).

However, the connection between the different types of knowledge and knowledge-constitutive interests with other elements of Habermas' later theory of communicative action is less clear. One is easily tempted to connect the different interests and types of knowledge with other threefold distinctions that Habermas proposes therein, for example, the distinction between: (a) the objective, the social and the subjective world; (b) the corresponding types of validity claims; (c) instrumental, strategic and communicative action; and (d) the cognitive-instrumental, moral-practical and aesthetic-practical rationality.

Trying to do this, however, confronts us with a number of problems such as:
(i) Should we perceive the practical or the emancipatory knowledge-constitutive interest (or both) as inherently connected with communicative action?
(ii) If we intuitively link the technical interest with the objective world and validity claims concerning truth, and the practical interest with the social world and validity claims related to normative rightness, we seem to get stuck, since it seems not very logical to link the subjective world and validity claims concerning authenticity with the emancipatory interest (even if Habermas proposes that psychoanalysis can be seen as an idealtypical model for a critical social science[19]).

Thus, there is a considerable need for clarification on the precise relation between Habermas' earlier and later work (see also Giddens, 1987). However, this is not the place for speculation and/or further philosophical investigation into this matter. Despite these unclarities, I will attempt to discuss the extent to which -amongst others- Habermas' conceptualization of knowledge and information meets the criteria formulated at the outset in the following section.

A critical evaluation of the prospects of Habermas' theory

In outlining the main elements of Habermas' theoretical framework, I have indeed come across several opportunities for both expanding the theoretical basis of extension science and furthering our understanding of the use and development of communication technologies.

First, Habermas' work explicitly deals with situations in which a variety of actors are actively engaged and aims at integrating actor theories and system theories, amongst others with the view of transcending determinism. Second, Habermas' conceptualizations of knowledge, information, rationality and communication are inherently connected with normative and political issues. Thus, one could argue that Habermas' approach comes a long way in meeting the criteria formulated at the outset. In addition, his theory seems relevant to extension scientists in that it can help to further develop the KIS perspective in a more critical and politically sensitive direction, and offers opportunities to ground claims stressing the theoretical importance and legitimacy of applied communication sciences. Also, by stressing the importance of argumentation and the existence of nomological knowledge, it indirectly helps authors in the PI perspective to resolve an ethical and theoretical problem, i.e. the separation of persuasive extension from advertising and/or manipulation. Moreover, the theory explicitly deals with communication technologies and their possible functions in society, and helps to raise a number of intriguing issues in relation to these.

In short, it is -at least at first sight- somewhat tempting to adopt Habermas' theory of communicative action as the guiding theoretical framework for my study. However, I will argue below that several intricacies are associated with: (a) the way in which Habermas' comes to meet the criteria that I have formulated towards the end of chapter 2; (b) the practical prospects for using Habermas' approach in extension situations; and (c) the suitability of Habermas' framework for dealing with diversity in agriculture.

(1) Empirical research shows that the occurrence and outcomes of interactions that in themselves might well be termed 'communicative action', can only be adequately understood if one recognizes that they are at the same time strategic actions *vis-à-vis* other communities of actors (see chapter 10). Whether or not actions are strategic or communicative, therefore, seems to depend on where one draws the boundaries between communities of actors (or a KIS for that matter) in time and space, which considerably blurs the distinction.

In relation to this, Habermas' framework seems to imply that the motor for future societal progress is consensus, whereas my study shows that this is only partly true since effective consensus among some (i.e. consensus that leads a specific set of actors to generate tangible 'progress') is frequently based on conflict and competition with others.

(2) It seems highly unrealistic that an 'independent' facilitator (or anyone else) could in practice create an 'ideal speech situation', and/or convince actors to set aside their personal or institutional interests[20]. This holds especially for the type of inter-institutional problems which the KIS perspective aims to resolve. Spending time and effort in order to create conditions for communicative rationality may in many instances prove a frustrating exercise, which by no means guarantees success (see chapter 10). I believe that extension scientists (and especially KIS adepts) wish to create an 'ideal speech situation' in social settings where Habermas himself would probably agree that this is misplaced and unproductive.

Furthermore, even if one assumes for a moment that the actors involved have no strategic interests, they will usually have differential resources at there disposal (e.g. in the form of knowledge, access to certain sources) with the help of which they can make and criticize certain validity claims concerning truth, normative rightness and authenticity. Thus, even if the opportunities to speak out are equal, the possibilities to make claims and criticize them are not. Moreover, even if the participants do not pursue their own interest, there is a practical limit to (self-)criticizing all the claims that are made. As a consequence -in Habermas terms- it is not unlikely that claims that "express ideologically frozen relations of dependence" may eventually be acted upon, which means that outcomes of communicative actions may serve strategic interests of actors that are not even directly involved in the interactions.

In all, communicative rationality emerges as a highly utopian notion, and in many cases it is doubtful whether its adoption as a guiding principle for communicative intervention will be productive or not. Too many participatory procedures have -in practice- turned out to be ritual facades in which very little real opportunities existed to influence the course of events. Thus, at best Habermas' notion may help extension agents to create *effective* higher quality collective agency in some cases, but in many contexts it may not, and in the latter Habermas' approach has little to offer to extension agents.

(3) Especially (but not only) in relation to farming, the appropriateness of Habermas' idea of the 'colonization of the life-world by the system' can be called into question. Studies on styles of farming (see section 5.1) have shown that farmers' economic activities and practices are coordinated on the basis of different *normatively* based strategies (Bolhuis & Van der Ploeg 1985; Van der Ploeg 1990; Leeuwis 1989; Roep et al. 1991; see also chapter 8). Moreover, studies on gender relations in agriculture (Aarnink 1987), show that, even in a highly specialised, differentiated and market-dependent agricultural sector, there is a close connection between the 'private domain' and the 'economic sphere', to the extent that

practices and organization in the latter can hardly be understood without taking account of the former, and vice versa. These existing normative and ideological 'controls' in the economic and political[21] spheres seem to indicate that what Habermas calls 'the life-world' and 'the system' are intertwined to such an extent that it becomes difficult -if not misleading- to speak of fundamentally different realms, one of which is somehow being 'colonized' by the other, rather than the other way around.

(4) Although Habermas recognizes that objective (in the sense of politically neutral) knowledge does not exist, he seems to locate the political aspect of knowledge in the context from which it emerges, and/or the context in which it is applied. This becomes most apparent in that he does not criticize or problematize the nature of nomological knowledge itself. In fact, he claims that nomological knowledge exists in both the natural and the social sciences.

This focus on the application of knowledge and techniques, rather than on their inherent nature, has been attacked by those who hold that knowledge and technique in themselves have a political 'code', irrespective of their application (e.g. Cristis, 1985; Mollinga & Mooij, 1989); in other words, they 'assume' a particular type of social organization. In the context of agriculture, the normative and political aspects of techniques have been quite convincingly shown (Van der Ploeg, 1987), amongst others in relation to communication technologies (Frouws & Van der Ploeg, 1988; Roep et al., 1991). Furthermore, constructivists like Latour (1987), Lynch (1985) and Knorr-Cetina (1981) have shown the social nature of scientific knowledge production in (even) the natural sciences, and have thereby made plausible that in this process social 'codes' can indeed be 'built-in'.

As Giddens argues, Habermas' model of the natural sciences (and thereby of technical knowledge) is too simplistic (1976:67-68), and does not deal adequately with the issues brought up by relativism (1987:245). At the epistemological level it has been argued convincingly by philosophers like Kuhn (1970) and Feyerabend (1975) that all observation is theory-laden, and this leads to major problems with respect to Popper's (1972) critical rationalism and 'falsificationism'. If it is impossible to verify a theory, how can one falsify a theory on the basis of observations that are in one way or another based on an (unverified) theory? Therefore, the practical validity of Habermas' distinction between the three knowledge-constitutive interests (technical, practical and emancipatory) becomes questionable. The same holds for his corresponding differentiation between three types of knowledge. That is, all knowledge can -in a particular context- have connotations of control, political and normative struggle and/or interpretative consensus, so that it becomes extremely difficult to distinguish between -in Habermas' terms- 'information', 'interpretations' and 'analysis'.

(5) Habermas' attempt to bring about an integration between actor theories and system theories (essentially by analyzing the symbolic reproduction of societies in action-theoretical terms, while describing the material reproduction in system-theoretical terms; Kunneman, 1983:10) does not lead to a great deal of insight with respect to understanding the interrelations between action and structure, i.e. the extent to which human action is, or is not, determined by outside structures.

An indication that Habermas holds a somewhat passive conceptualization of actors is his apparent contention that the social sciences can produce nomological knowledge; that is, the idea that social action obeys certain law-like regularities. Furthermore, Habermas' distinction between the system and the life-world, his description of the interrelations between the two, and their emergence through time, does seem rather functionalistic (even if Habermas (1981b) explicitly criticizes functionalist reasoning) and/or reified. It does at least not give much insight into how actors were actively involved in shaping the processes of twofold differentiation and colonization, or the operation of political and economic 'steering mechanisms'. This is remarkable, since at the same time Habermas optimistically assumes that actors (in the form of social movements) can effectively reverse the colonization of the life-world.

(6) Another issue, which -at first sight- seems less directly relevant to my study, is that Habermas' description of social evolution is rather unilinear and Eurocentric. His claim that the process of social evolution reflects a process of expansion of rationality, implies that non-Western cultures are in fact less rational than modern Western societies. Although Habermas recognizes that the world views of other cultures cannot only be evaluated on their cognitive merits, he does indeed argue (building on Evans-Pritchard's (1950) analysis of magic and witchcraft among the Azande) that some cultures can reach more objectively truthful statements than others (Habermas, 1981a:29ff). Again, Habermas avoids some of the quite convincing arguments raised by relativists, most notably (and analogous to what Gödel (1962) has shown for sets of mathematical propositions) that:

> "We have to recognize (...) that any endeavour to ground the rationalism of science within the structure of science as such finds itself in a logical circle. But this is only a vicious circle if its closing is treated as an end-point of enquiry, rather than as a beginning. There is *no way* of justifying a commitment to scientific rationality rather than, say, to Zande sorcery, apart from premises and values which science itself presupposes, and indeed has drawn from historically in its evolution within Western culture" (Giddens, 1976:139-140).

This discussion can be brought closer to the subject if we recognize that different rationalities and subcultures do also exist within Western societies. As studies on farming styles have demonstrated (see section 5.1), it is possible to distinguish between different cultural patterns or cultural repertoires within the farming community, and the same could probably be argued for the scientific community as well. Habermas' theory of rationality seems inadequate to deal with such diversity because of the internal contradiction that, on the one hand, action is considered to be rational when it emerges on the basis of communicatively rational procedures, whereas, on the other hand, Habermas apparently claims that it is possible to identify some communicative actions as more rational than others. Clearly, this paradox is tied up with his unproblematic acceptance of the existence of nomological knowledge, which I have discussed before.

In sum, my conclusion must be that an adoption of Habermas' framework does not help to conceptualize satisfactorily the social dimensions of knowledge, information, communication and rationality, nor does it help much to develop a more active view on human agents and/or deal with strategic diversity. Thus, it seems unsuitable for improving our understanding of the use and development of communication technologies in agriculture. Similarly, it insufficiently provides extension scientists with an adequate framework for dealing with 'multi-actor' intervention contexts.

5.3 Communication and Giddens' theory of structuration

Given the intricacies connected with Habermas' work, I will continue my search for appropriate sociological conceptualizations with an exploration of Giddens' theory of structuration. Giddens' conceptualization of communication and related concepts must be seen in the context of his attempt to bridge the long-standing controversy between structuralist and interpretative approaches in sociology.

The conceptualization of action and structure

According to Thrift (1982) a new consensus may be arising in social theory with regard to the action/structure debate; he asserts that there are a number of common characteristics in the theoretical approaches developed by authors like Bhaskar (1989), Bourdieu (1990), Layder (1981) and Giddens (1976, 1979, 1984), which he labels as belonging to the School of Structuration. One of these characteristics being that they explicitly try to overcome the actor/structure dualism; that is, they do not try to solve the dualism by choosing position in it, but they tend to problematize the dualism itself (Munters et al., 1985:12).

Giddens and others react to a number of well-established theoretical approaches in social theory. On the one hand, there are approaches with rather deterministic implications, such as functionalism (e.g. Durkheim, 1966; Parsons, 1951), Marxism (Marx, 1977; Althusser, 1969), structuralism (Lévi-Strauss, 1972; Foucault, 1974) and some recent versions of symbolic interactionism[22] (e.g. Stryker & Statham, 1985). Despite the many differences between these theoretical approaches, they seem to share a notion of actors as rather passive creatures whose conduct is somehow determined by external forces that operate 'behind their back'. Giddens characterizes these approaches as being "strong on institutions, weak on action" (Giddens, 1985:33). As I have shown, many authors in informatics, information management studies and studies on communication technology in organizations have affinity with some of these approaches.

On the other hand, more interpretative perspectives exist, such as 'hermeneutic philosophy' (Weber, 1949), phenomenology (Husserl, 1962; Schutz, 1972), ethnomethodology (Garfinkel, 1967), 'ordinary language philosophy' (Wittgenstein, 1969; Austin, 1970) and post-Wittgensteinian philosophy (Winch, 1971) (see for a discussion of these Giddens, 1976). These approaches have in common that they share an interest in the 'interpretative understanding' of human conduct (Giddens, 1976:23) and -in relation to this- start from a much more active conceptualization of human conduct. At the same time, however, these perspectives tend to neglect issues of power and institutional transformation (Giddens, 1976:53), which gives them a somewhat voluntaristic flavour. Therefore, Giddens characterizes them as being "strong on action, weak on institutions" (Giddens, 1985:31).

In order to overcome this theoretical deadlock, Giddens -in what he calls a "positive critique of interpretative sociologies" (1976)- proposes to change the focus of analysis in the social sciences:

> "The basic domain of study of the social sciences, according to the theory of structuration, is neither the experience of the individual actor, nor the existence of any form of social totality, but *social practices* ordered across space and time" (Giddens, 1984:2; emphasis CL.).

Furthermore, actors who are involved in such social practices are to be viewed as active and knowledgeable agents; that is, "all social actors know a great deal about the conditions and consequences of what they do in their day-to-day lives" (Giddens, 1984:281). Such knowledge, according to Giddens, can either arise from actors discursive or practical consciousness[23]. Recognizing that actors are knowledgeable is not to say that they are all knowing:

> "The knowledgeability of human actors is always bounded on the one hand by the unconscious and on the other by unacknowledged conditions/unintended consequences of action" (Giddens, 1984:282).

The practices that human beings are involved in, according to Giddens, are recursive; that is:

> "they are not brought into being by social actors but continually recreated by them via the very means whereby they express themselves *as* actors. In and through their activities agents reproduce the conditions that make these activities possible" (Giddens, 1984:2).

In relation to this, Giddens speaks of the 'duality of structures', which means that structure has to be seen as "the medium and outcome of the conduct it recursively organizes" (1984:374). More precisely, structure is seen as recursively organized sets of "rules and resources, or sets of transformation relations, organized as properties of social systems" that are "out of time and space, save in [their] instantiations and co-ordination as memory traces" (1984:25). Social systems, then, are defined by Giddens as "reproduced relations between actors or collectivities, organized as regular social practices" (Giddens, 1984:25). Thus, "social systems, as reproduced by social practices, do not have 'structures' but rather exhibit '*structural properties*'", while "structure exists, as time space presence, only in its instantiations in such practices and as memory traces orienting the conduct of knowledgeable human agents" (Giddens, 1984:17; emphasis CL.). In other words, structure does not have an objective and/or determining existence 'behind the back of the actor'.

Structural properties, then, can be seen as the outcome of the operation of 'rules and resources' at system level, and are defined by Giddens as: "Institutionalized features of social systems, stretching across time and space" (Giddens, 1984:185)[24].

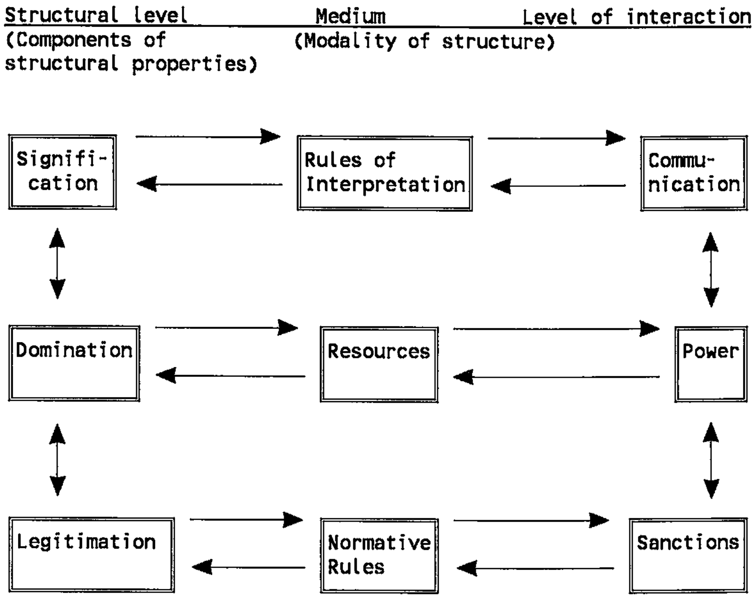
In their interaction (i.e. through social practices) actors -through the mediation of 'rules and resources'- produce and reproduce 'structural properties' that can be conceptually divided in three components of equal value (signification, domination, and legitimation). In figure 5.1 the conceptualization of structure is schematically summarized.

The three components that are explicated by Giddens can only be distinguished analytically:

> "The communication of meaning in interaction does not take place separately from the operation of relations of power, or outside the context of normative sanctions. All social practices involve these three elements" (Giddens, 1979:81-82).

Below, I will briefly discuss the three above mentioned components of interaction, structure and structural properties.

Figure 5.1: Conceptualization of the relation between structural properties of social systems and human action (free from Munters et al, 1985:87 and Giddens, 1984:29).



Signification - Rules of Interpretation - Communication

Firstly, interaction implies the production of meaning in communication, i.e. signification. The production of interaction as meaningful, according to Giddens (1976:104-107), depends upon "the mutuality of 'uptake' (Austin) in communicative intent" and in the understanding of the motives of the actors involved, and -as I would like to add- upon the evaluation of the communicative content in relation to these.

In the production of meaning actors make use of 'rules of interpretation' (or interpretative schemes) that originate from to what Giddens calls 'mutual knowledge', which he defines as:

> "taken-for-granted 'knowledge' which actors assume others possess, if they are 'competent' members of society, and which is drawn upon to sustain communication in interaction. (...) Mutual knowledge is 'background knowledge' in the sense that is taken for granted, and mostly remains unarticulated; on the other hand it is not part of the 'background' in the sense that it is constantly actualized, displayed, and modified by members of society in the course of their interaction. Taken-for-granted knowledge, in other words, is never fully taken for granted, and the relevance of some particular element to an encounter may have to be 'demonstrated', and sometimes fought for, by the actor; it is not appropriated ready-made by actors, but is produced and reproduced anew by them as part of the continuity of their lives." (Giddens, 1976:107).

The creation of meaning, even without such 'openly' arising conflict, is inherently connected with the operation of power and norms in social interaction, and might therefore be described as a contextual 'negotiation' process:

> "the creation of frames of meaning occurs *as the mediation of practical activities*, and in terms of differentials of power which actors are able to bring to bear. (...) The reflexive elaboration of frames of meaning is characteristically imbalanced in relation to the possession of power" (1976:113).

Legitimation - Normative Rules - Sanctions
Analytically speaking the medium for the production of moral order in interaction is norms, which can be seen as a special sub-category of rules, that -like other elements of structure, and contrary to the conceptualizations of Durkheim, Schutz, Winch and others- are both constraining *and* enabling (1976:108). Norms are rules that have relation to moral evaluations of 'good' and 'bad', or, as Giddens puts it, as rules that relate to the actualization of rights and the enactment of obligations (Giddens, 1976:108). Since such rights and obligations are by no means automatically effectuated, Giddens proposes to treat all normative elements in human interaction as:

> "a series of *claims* whose realization is contingent upon the successful actualization of obligations through the medium of the responses of other participants" (1976:108).

Such claims, or social norms, can be treated by actors in the same manner as technical prescriptions (for which sanctions -in case of violation- follow in a 'mechanical' manner) in the sense that actors strategically decide to follow it:

> "a normative claim may be acknowledged as binding, not because an actor to whom it applies as an obligation accepts that obligation as a moral commitment, but because he anticipates, and wants to avoid, the sanctions which will be applied in the case of his non-compliance" (1976:109).

This, and the fact that the definitions of both compliance/non-compliance and the nature of appropriate sanctions[25] can be subject to negotiation, only shows that the constitution of interaction as moral order is closely connected with both the production of meaning and the operation of power relations.

Domination - Resources - Power
According to Giddens, the notion of action[26], and therefore the notion of interaction, is "logically tied to that of power" in the sense that "action intrinsically involves the application of 'means' to achieve outcomes" (1976:110). Thus, action is transformative, and therefore 'power' must be involved. Such power', in the sense of the transformative capacity of human action (or agency; see also Long's definition quoted in section 5.1) is:

> "the capability of the actor to intervene in a series of events so as to alter their course; as such it is the 'can' which mediates between intentions or wants and the actual realization of the outcomes sought after" (1976:111).

This idea, that even those that are subordinate can influence the activities of their superiors is what Giddens calls the *dialectic of control* in social systems (1984:16).

Power, defined in this very broad manner, is clearly involved in all (inter)action, and for social interaction this is equally true when power is defined in a more narrow sense as

> "the capability to secure outcomes where the realization of these outcomes depends upon the agency of others. It is in this sense that men have power 'over' others: this is power as *domination*" (1976:111).

In order to exert power in social interaction, actors mobilize and bring in resources (or facilities) of various types as means to influence the course of events. Giddens (1976:112) asserts that power (as mediated by resources) can somehow be"'stored up' for future occasions of use" (a claim that I will criticize to some extent in the next section). Also, it is implied by Giddens' conceptualization of power that power is not logically connected to conflict (which seems to be implied by Weber's definition of power[27]). Instead conflict seems to be directly connected to the concept of 'interest', but "while power is a feature of every form of human interaction, division of interest is not" (1976:112).

A constructivist (but positive) critique

Before turning to a more elaborate discussion of Giddens' conceptualization of knowledge, information, communication and rationality I will first raise some critical points in relation to Giddens' treatment of the actor/structure debate.

(1) Although Giddens explicitly recognizes context dependence as "integral to the production of meaning [as mediated by rules of interpretation, CL] in interaction" (1976:105), he seems to partly avoid the issue of contextuality in his discussion of moral order (mediated by normative rules), and relations of power (mediated by resources). This relates directly to my impression that -when he illustrates how the three components of structure can only be distinguished analytically, and are in fact "subtly yet tightly interwoven" in social life (1976:104)- he seems to stress how power and norms affect the production of meaning rather than the other way around[28].

This brings me to the question of what exactly the analytical status of the 'rules and resources' is, and how they are interrelated. First, in my view normative rules and resources are in fact sub-categories of rules of interpretation. What is, or is not considered and accepted as a resource in a particular interaction context depends eventually on an 'agreement' on what is to be *interpreted* as such. Similarly, the question of what is 'good' or 'bad', moral or immoral, a right or an obligation, is -in the end- a matter of interpretation. This is not to say that Giddens subdivision is unhelpful; I only emphasize that it logically follows from this that not only the rules of interpretation relevant to a particular context are actively negotiated, but that this also applies to the normative rules and resources that mediate the interaction.

Second, this implies that there is always a variety of rules of interpretation, normative rules and resources that can be created and/or drawn upon in interaction (Gilbert & Mulkay (1984) speak of 'interpretative repertoires'). Rules and resources, then, are not stable entities that are inherently connected to specific types of contexts, collective or even individual actors; as Knorr-Cetina puts it:

> "the person manifests a multiplicity of personas which [in different social theories] have been linked to social roles, to the management of the self, or simply to different situations" (1988:24)[29].

Thus, the rules and resources that bear relevance to a particular interaction can -strictly speaking, and if the appropriate methodological tools would exist- only be identified *after* the interaction took place.

A methodological implication of my interpretation of Giddens' structuration theory is that social practices (which according to Giddens should be the primary object of study) must be analyzed in relation to the context in which they take place. This is in fact the essence of what Knorr-Cetina calls 'methodological situationalism'[30].

(2) If -as I argue- 'methodological situationalism' is a logical consequence of Giddens' theory of structuration, there is a need to clarify how 'macro' concepts within this theory (such as 'regular social practices', 'structural properties', etc.) fit in; in other words, what is the relation between different 'micro' contexts, and how do we conceptualize 'macro'-phenomena in relation to this?

Giddens argues that unintended consequences of intentional action in 'micro' contexts are very important in explaining 'macro' properties of society. Giddens mentions three (only analytically distinguishable) contexts in which unintended consequences of intentional action in a particular context can bear relevance to other contexts (1984:13-14).

First, a particular intentional action can trigger off a chain of interactions which have no relation with the original intentions of the actor (e.g. someone turns on a light to illuminate a room; a prowler is alerted and flees; the prowler runs into a policeman, etc.).

Second, a particular situation or outcome can be explained as an unintended consequence of a larger number of 'parallel' (chains of) interactions between intentional actors. Over-production and environmental degradation in agriculture, for example, are outcomes of a complex interaction between policy makers, farmers, scientists, agro-industries, etc., while we can presume that none of these actors explicitly intended to create the outcome.

Third, unintended consequences of institutionalized practices can form unacknowledged conditions[31] for the (re)production of these very practices. An unintended consequence of a rain-making ceremony, for example, may be that community members may develop a greater spirit of 'solidarity'; this spirit of solidarity in turn may in fact be an important condition for the continued organization of the ceremony in time and space. At this point, Giddens rejects Merton's more functionalistic claim that the existence of such a ceremony should be seen as a 'latent function':

> "to suppose that such a demonstration of a functional relation provides a *reason* for the existence of a practice is mistaken. What is more or less surreptitiously smuggled in here is a conception of 'society's reasons' on the basis of imputed social needs" (Giddens, 1984:12; emphasis CL.).

> "To understand what is going on no explanatory variables are needed other than those which explain why individuals are motivated to engage in regularized social practices in time and space, and what consequences ensue" (1984:14).

By explicitly rejecting the 'latent function' interpretation of unintended consequences, Giddens successfully combats Knorr-Cetina's (1981; 1988) criticism that his unintended consequences perspective has deterministic and esoteric implications. The implications of Giddens' latest quote are in fact the same as Knorr-Cetina's conclusion that "there is nothing esoteric about unintended consequences" (1988:36), and that "from the micro-scale perspective upon events, the overall outcome of the series [of action-reaction sequences] is perfectly intelligible" (1988:39).

This is not to deny, however, that Knorr-Cetina provides us with an additional and very useful concept for analyzing the relation between macro-phenomena and micro-contexts, which -in my view- is perfectly compatible with Giddens' conceptualization of structure.

Knorr-Cetina introduces the concept of *representation*, and argues that we can see the macro "as a summary representation actively constructed and pursued within micro-situations" (1988:39). This is to say that in the (re)production of practices, actors refer to macro-phenomena such as 'the State' or 'the market' by means of representations of it; these representations are necessarily 'summary' representations, for example, in the form of statistical figures, simplifications, metaphors, images, etc. Structural regularities, then:

> "are tied to participants' actual practices instantiated in networks of mutually related (via representations) micro-transactions which coexist parallel to each other" (1988:43).

Thus, structural properties arise from 'common' representations that actors draw upon in networks of interaction in time and space.

If one recalls that in its most abstract sense Giddens' definition of structure amounts to 'rules of interpretation' that mediate interaction, and if one agrees that putting forward a particular representation of something is in fact the same as proposing the relevance of a particular rule of interpretation in relation to it, one must conclude that both approaches are quite compatible.

(3) So far it seems not very problematic to reformulate and/or interpret Giddens' theory of structuration in a somewhat constructivist manner. I have argued that it logically follows from Giddens' theory that not only rules of interpretation, but also the normative rules and the resources that mediate interaction are actively negotiated. This implies, however, that we have to accept partly Latour's statements that "power is not something one can possess - indeed it must be treated as a consequence rather than as a cause of action" (1986:264). Thus:

> "the notion of power may be used as a convenient way to *summarise* the consequence of a collective action, it cannot also *explain* what holds the collective action in place" (1986:265).

> "... society is not what holds us together, it is what is held together. Social scientists have mistaken the effect for the cause, the passive for the active, what is glued for the glue. Appealing to a reserve of energy, be it 'capital' or 'power', to explain the obedient behaviour of the multitudes, is thus meaningless. This reservoir is full only as long as you do not need it, that is as long as others dutifully fill it. It is empty when you need it, that is when the others are no longer filling it. There is no way out of this paradox. No matter how much power one appears to accumulate, it is always necessary to obtain it from the others who are doing the action - this is what I called the shift from diffusion to translation" (1986:276).

As I have shown earlier on, Giddens still maintains a type of 'reservoir' conceptualization of power, which -in my view- is in fact a logical inconsistency within his theory. At the same time, I would not go as far as Latour in claiming that power is only an effect and not a cause of action, and therefore that we must abandon the notion of power altogether (1986:278).

In this study I will start with Giddens, who argues that power is mediated by resources, and add to that, that this implies that power is mediated by rules of interpretation. Thus, one can 'exert power' if one manages to make others draw upon certain rules of interpretation (that is, 'impose' what Knorr-Cetina calls representations, or what Latour calls definitions) which -paradoxically- depends on bringing relevant resources into the interaction, which implies again that one needs again to make people draw upon a rule of interpretation (that the 'resource' is indeed a resource), etc.

At this point it becomes very clear that concrete interactions must be looked at in the context of other interactions in time and space, since above mentioned conceptualization of power only makes sense if one assumes that actors have 'agreed' upon certain rules of interpretations in the past, and/or anticipate to agree upon these in the future. The basis of power, then, is in fact mutual knowledge (as inherently connected with mutual ignorance, see section 5.1). This body of knowledge has of course been created in previous interactions in which power has played its part as well. Thus, in this historical sense, power is not only an outcome of a particular interaction, but also a cause.

Giddens, knowledge, information and communication

In the preceding sections I have already touched on a number of important insights and implications that arise from Giddens' theory of structuration in relation to the conceptualization of knowledge, information and communication. It has emerged that: (1) communication is an inherent component in all social interaction, and (2) that the production of meaning (and therefore the production of knowledge and information) is inherently connected with the operation of power and normative sanctions; thus, meanings are socially negotiated. Furthermore, it became clear that: (3) in this negotiation process people draw upon 'mutual knowledge', and (4) that there is a close interrelation between structure, mutual knowledge, mutual ignorance and power.

Below, I will briefly discuss some implications of these conceptualizations in relation to some important issues that I have touched upon earlier on.

First, Giddens' conceptualizations support my earlier claim that differentiating between knowledge, information and data is unhelpful, and that we may more fruitfully speak of 'knowledge constructs' instead (see section 4.2). The assessment that meanings are socially negotiated implies that both natural triggers and human 'information products' like books and computer programs in themselves have no unambiguous meaning. They only become meaningful in particular interaction contexts, in which actors simultaneously draw upon rules of interpretation, and create new ones.

Knowledge, then, can be perceived as the 'reservoir' (or 'repertoires') of rules of interpretation that actors can draw upon in the creation of knowledge constructs (such as numbers, parameters, texts, meanings, models) and is embedded in the 'life-world' (see Leeuwis et al.'s description quoted in section 5.1). Giddens' concept of 'mutual knowledge', then, can be seen as the more or less overlapping part of actors' life-worlds within a particular network or community, through which "actors constitute and understand social life as meaningful" (Giddens, 1976:115).

Second, it is significant to note that the socially constructed nature of knowledge holds equally for laymen, clergy, magicians, *and* natural or social scientists (see e.g. Knorr-Cetina, 1981; Lynch, 1985; Latour, 1987). Scientific communities may be characterized by different organizational principles, interests, ideologies, criteria for validating knowledge claims, ceremonies, resources, structural properties, etc., than religious communities, tribes, villages, commercial firms, etc., but this supports rather than contradicts the point made. In all, Giddens' conceptualization of the difference between scientific and non-scientific knowledge (see e.g. Giddens, 1976) is consistent with the one that follows from an actor-oriented perspective (see section 5.1.).

Third, in arguing along the lines that I have chosen, one always ends up with the question whether or not 'reality', 'an objective natural and/or social world' or 'truth' exists (see also my discussion on nomological knowledge in section 5.2). I will not go as far as some extreme relativists that there exists no such thing as objective reality or objective facts. Rather, I would like to conform to the position that Knorr-Cetina (1981) seems to take, namely that -from a social scientific perspective- it is *irrelevant* whether or not it exists, since for human beings it is fundamentally impossible to know it, even if it existed. All human knowledge is -in the end- temporary, selective, contextual and socially negotiated, and this holds equally for knowledge about what is commonly labelled the 'natural world' and the 'social world'.

This is not to deny that an autonomous natural world exists. Indeed, the natural world 'produces' significant triggers and feedback which mankind would do wise not to ignore. Moreover, mankind has learned to quite successfully manipulate and predict autonomous natural processes. The point is, rather, that neither human interpretations of such triggers, nor the predictions or manipulations made, can be fully neutral or objective, for they are inherently constructed in social life.

Similarly, I do not wish to imply that 'anything goes'. As Benvenuti (pers. comm.) rightly implied, any community or society must develop norms and criteria with respect to what is valid knowledge and what is not, if only in an effort to combat fascism and/or prevent environmental degradation and nuclear disaster. Nevertheless, it must be recognized that such norms and criteria are not neutral, and therefore there is reason to critically evaluate them regularly.

Finally, my argument does not imply that it is useless for social scientists to generate knowledge. Quite the contrary; the creation of knowledge is an inherently political activity, and if one wishes to contribute to societal change, it is crucial to be able to put forward (and defend) new rules of interpretation in specific micro-contexts. As Giddens makes clear when arguing that mutual knowledge is underpinned by what he calls 'commonsense', 'experts' (e.g. social scientists or for that matter extension agents) have a potential to influence mutual knowledge, which -in my interpretation of Giddens' work- means that they have a potential to induce 'structural' change:

> "[commonsense] can be regarded as comprising a more or less articulated body of theoretical knowledge that can be drawn upon to explain why things are as they are, or happen as they do, in the natural and social worlds. (...) It is normally in some substantial degree derived from, and responsive to, the activities of 'experts', who make the most direct contribution to the rationalization of culture. 'Experts' include all those who have [or -as I would like to put it- claim

to have and/or manage to let others interpret them as having, CL] the authority of privileged entrée to realms of specialized knowledge - priests, magicians, scientists, philosophers. Commonsense is certainly in part the accumulated wisdom of laymen; but commonsense beliefs just as certainly reflect and embody the perspective developed by experts" (1976:115).

According to Giddens, the phenomenon that -in time and space- there can be a complex interaction between the way in which 'ordinary' human agents interpret the world, and the way social scientists think, write and speak about it, implies that social scientific knowledge is characterized by a '*double hermeneutic*' (1976:158). That is, social scientists interpret a social world that is constituted by the hermeneutic activities of social actors, whereby the latter may very well draw upon social scientific interpretations. This can be looked at as strength of the social sciences in the sense that social scientific knowledge has the potential to change the rules that are drawn upon in the social world. In contrast, natural scientists cannot hope to alter the basic workings of the natural world. In fact, this book reflects my intention to capitalize on this particular characteristic of the social sciences. The methodological implications of this position will be discussed in section 6.3.

Giddens and rationality

In his theory of structuration, Giddens' speaks of 'rationalization' and 'reflexive monitoring of action' rather than of 'rationality'. This, because the concept of rationality is logically tied up with notions such as 'goal-oriented action', 'intentions', 'reasons' and 'motives', which according to Giddens (1976:156):

> "are all potentially misleading terms, in that they already presuppose a conceptual 'cutting into' the continuity of action, and are aptly treated as expressing an ongoing reflexive monitoring of conduct that 'competent' actors are expected to maintain as a routine part of their day-to-day lives. The reflexive monitoring of action only becomes the statement of intentions, or the giving of reasons, when actors either carry out retrospective enquiries into their own conduct or, more usually, when queries about their behaviour are made by others".

In order to refer to the goal-oriented aspect of day-to-day practices he uses the terms 'intentions' and 'purpose' as equivalent terms, while he reserves the term 'project' to refer to longer term ambitions (1976:76). He strongly emphasizes that "neither intentions nor projects should be equated with *consciously held-in-mind* orientations towards a goal", and thus, that habitual or routine conduct, including "the most mundane forms of day-to-day conduct" should be seen as intentional action, even if no conscious reflection takes place (1976:76). Therefore he defines intentional action as:

> "any act which an agent knows (believes) can be expected to manifest a particular quality or outcome, and in which this knowledge is made use of by the actor in order to produce this quality or outcome" (1976:76).

Thus, intentional action implies the 'use' of knowledge (or rules of interpretation), which in fact implies that *all* human action is knowledgeable and intentional (even if not necessarily 'adequate' or discursive).

According to Giddens, it is misleading to 'chop up' courses of action as a chain of intentional activities, as seems to be implied by many approaches discussed in the chapters 3 and 4:

> "the purposive content of everyday action consists in the continual successful monitoring by the actor of his own activity; it is indicative of a causal mastery of the course of day-to-day events that men normally take for granted. (...) One's life-activity does not consist in a strung-out series of discrete purposes and projects, but in a continuing stream of purposive activity in interaction with others and with the world of nature; a 'purposive act', like act identifications more generally, is only grasped reflexively by the actor, or isolated conceptually by another agent" (1976:82-83).

The reflexive nature of human actors' knowledgeability is a crucial aspect that facilitates the recursive (re)production of social practices, as implied by Giddens' concept of duality of structure:

> "Continuity of practices presumes reflexivity, but reflexivity in turn is possible only because of the continuity of practices that makes them distinctively 'the same' across space and time. 'Reflexivity' hence should be understood not merely as 'self-consciousness' but as the monitored character of the ongoing flow of social life" (1984:3).

This close connection between reflexivity and the operation of structure means that the reflexive monitoring of action is inherently a *social* -and not an individual- process:

> "actors not only monitor continuously the flow of their activities and expect others to do the same for their own; they also routinely monitor aspects, social and physical, of the contexts in which they move" (1984:5).

An element of the reflexive monitoring of action is what Giddens calls *rationalization*; that is, the process of *reasoning* about the logical interconnections between identified intentional activities and/or the 'technical grounding' of the knowledge that is drawn upon in (inter)action. Thereby '*reasons*' (which differ from intentions[32]) can be conceptualized as "grounded principles of action which agents 'keep in touch with' as a routine element of their reflexive monitoring of their behaviour" (Giddens, 1976:83). However, such often retrospectively formulated 'reasons' for action can not be simply perceived as 'causes' for action since there is considerable disagreement on whether or not 'reasons' and 'action' can be perceived as independent entities in the first place[33].

> "Rather than simply saying reasons are, or may be, causes, it is more accurate to say that rationalization is the causal expression of the grounding of the purposiveness of the agent in *self-knowledge* and in knowledge *of the social and material worlds* which are the environment of the acting self" (1976:85).

In my view, it is implied by Giddens' definition of intentional action and the inherent connection that Giddens makes between, on the one hand, intentions, projects and reasons, and on the other, knowledge, that the former too are -at least partly- socially constructed. In this respect, Giddens is less clear about 'motives' and 'interests' which also underlie intentions and projects, and which -in contrast to intentions, projects and reasons- may not be accessible to actors' consciousness[34]. Hindess (1986), however, has argued pervasively that interests too are of a contextual and negotiated nature[35]. Moreover, Giddens' argument that motives and interests express themselves usually through actors' projects, means that at least their consequences are socially constructed.

In all, Giddens' sociological argument implies that the notion of rationality is misleading, and that rationalization is best perceived as an element in the continuous monitoring of action that actors inherently engage in. Since his conceptualizations imply that to a large extent both processes are *social* processes, it can indeed be argued that Giddens' conceptualization of 'rationality' meets the criterium formulated at the outset.

Conclusion

Giddens' theory of structuration is indeed useful for conceptualizing the social dimensions of communication, knowledge, information and rationality. The implications of Giddens' theory with respect to knowledge and information are largely in line with those that follow from an actor-oriented perspective (see section 5.1). In contrast to Habermas' position, however, Giddens proposes that all social interaction has a communicative dimension and that the production of meaning (and therefore the production of knowledge and information) is *inherently* connected with the operation of power and normative sanctions. Furthermore, the theory of structuration seems better equipped than Habermas' theory of communicative action to demonstrate how actors are *actively* involved in (re)producing social structure. Moreover, Giddens makes clear that -in processes of negotiating meaning and action- actors draw upon (different repertoires of) mutual knowledge. From a constructivist perspective, then, such mutual knowledge (as inherently connected with mutual ignorance) can be seen as the key modality of structure, and therefore as underlying the existence of structural properties and the operation of power. In this respect, Giddens' theory offers a much more systematic and elaborate insight in the interrelations between action, structure, knowledge, communication and rationality than Long & Van der Ploeg's (1991) actor-oriented sociology of rural development.

Notes

1. At this point, Long adds that it is important to distinguish between a 'culturally endogenous' construction of the social actor which "is based upon the kinds of representations characteristic of the culture in which the particular social actor is embedded", and the construction of the actor by the researcher, which arises from a different cultural orientation (i.e. theoretical schools of thought) (1990:9).

2. Benvenuti (1991a:112-113) emphasizes the fluid and multifold nature of structure, and points to the fact that mental constructs (such as 'the vanguard farm', 'sustainability' and 'viability') can have structuring consequences, even if they are not empirically rooted.

3. Clearly, the various forms of 'non-scientific' knowledge mentioned have different connotations. The terms 'techne' (Marglin, 1991a, 1991b) and 'indigenous knowledge' (Warren, 1991; Richards, 1985, 1991) mostly refer to shared knowledge among particular cultural and/or ethnic communities. The term 'local knowledge' (Richards, 1985, 1991; Röling, 1988; Van der Ploeg, 1987) clearly has a spatial dimension, but is often used in combination with cultural connotations. The concept of 'l'art de la

localité' (Mendras, 1970; Van der Ploeg, 1987; Frouws & Van der Ploeg, 1988) points to the *specific* (and not necessarily localized) character of non-scientific knowledge. In relation to agriculture, for example, Frouws & Van der Ploeg (1988:28) argue that farmers' knowledge is specific in that (a) it arises from the permanent interaction between manual and intellectual labour (i.e. it is connected with craftsmanship), and that it needs to be understood in the context of (b) a particular unit of production and reproduction, and (c) a production process that is neither fully quantifiable nor predictable.

4. The term 'algorithmic compressibility' of the world is derived from Barrow (1990), and is used by Benvenuti to refer to the phenomenon that computability is increasingly becoming the new basis for cognition among large communities of scientists.

5. Such social interfaces are defined by Long (1989:2) as: "critical points of intersection or linkage between different social systems, fields or levels of social order where structural discontinuities, based upon differences of normative value and social interest, are most likely to be found."

6. Nomological knowledge is knowledge based on empirical laws and regularities (see Koningsveld & Mertens, 1986:12).

7. Habermas somewhat confusingly classifies instrumental action as constituting a 'non-social action situation', whereas he speaks of a 'social action situation' in case of strategic action. This 'social' versus 'non-social' dimension is confusing in the sense that it might be concluded that instrumental action only involves human interactions with the material world, or that -even if one assumes that behavioural sciences can produce nomological knowledge- all situations in which uncertainty exists on the behaviour of others could be legitimately termed strategic action situations.
Several authors (e.g. Gäfgen, 1980; McCarthy, 1978; Koningsveld & Mertens, 1986) have pointed to this obscurity. Following McCarthy and Gäfgen, Koningsveld & Mertens (1986:35-40) propose to make a sharp distinction between *lack of information* and *strategic insecurity*; thereby they suggest to label all actions in which an actor -or 'social-technician' (1986:37)- starts from the premise that human behaviour can be described by means of nomological knowledge as 'instrumental action', including those 'technical learning situations' in which it is recognized that insufficient nomological knowledge is available.

8. Thus, cognitive-instrumental rationality is in practice closely affiliated with both the realm of science and technique, and the realm of social technology (Habermas, 1981a:326). When we adopt Koningsveld & Mertens wider interpretation of instrumental action, therefore, we can conclude that there is a logical connection between this type of action and cognitive-instrumental rationality; if we stick Habermas' original conceptualization, it seems that we have to extend this logical connection to strategic action as well.

9. Where cognitive-instrumental rationality is closely affiliated with the realm of science, technique and social technology, the moral-practical type of rationality is connected with the realms of justice/law and morale, while the aesthetic-practical rationality dominates the realms of erotics and art (Habermas, 1981a:326).

10. Habermas (1981a:45) distinguishes between several forms of argumentation that can be relevant in the context of communicative action, i.e. theoretical discourse (theoretischer Diskurs), practical discourse (praktischer Diskurs), aesthetical critique (ästhetische Kritik), therapeutic critique (therapeutische Kritik) and explicative discourse (explikativer Diskurs). Habermas' distinction between discourse and critique refers to the extent to which reference can be made to universal claims; where in a discourse it is possible to make such universal claims, in a critique it is not.

Theoretical discourse involves the discussion of validity claims concerning the truth of (nomological) propositions and the effectiveness of goal-oriented activities, and therefore reflects the cognitive-instrumental aspect of communicative rationality.
Practical discourse involves the discussion of validity claims concerning the rightness of norms for behaviour (Handlungsnormen), and therefore reflects the moral-practical aspect of communicative rationality.
Aesthetic critique involves the discussion of validity claims concerning the appropriateness of value judgements (Angemessenheit von Wertstandards) related to the authenticity of works of art, and therefore reflects the aesthetic-practical aspect of communicative rationality.
Therapeutic critique involves the discussion of validity claims concerning the veracity of expressions (Wahrhaftigkeit von Expressionen), and therefore reflects another aesthetic-practical aspect of communicative rationality.
Finally, explicative discourse involves the discussion of validity claims concerning the shapeliness (Wohlgeformtheit) or consistency (Regelrichtigkeit) of symbolic constructions, given a particular set of (mathematic, linguistic etc.) rules. (Habermas, 1981a:39-45).

11. Modern society is a product of a process of social evolution which Habermas describes as a (rather unilinear) twofold process of differentiation (1981b:230). On the one hand, the system and the life-world become increasingly differentiated internally; that is, the system becomes an increasingly complex, specialized and interdependent set of political and economic institutions, while the life-world is subject to a process of (communicative) rationalization whereby its objective, social and subjective dimensions become increasingly differentiated. Habermas argues that the rationalization of the life-world is a precondition for system-differentiation. On the other hand, Habermas argues that in modern societies (i.e. ökonomisch konstituierte Klassengesellschaften; 1981b:249) system and life-world become increasingly disconnected, in the sense that arenas of societal interaction arise that are out of reach of communicative rationality; i.e where actors can only operate in a cognitive-instrumentally rational, and therefore normatively neutral, manner. A precondition for this disconnection was the anchoring or institutionalization (Verankerung) of *power* and *money* as legitimate media for coordination in the life-world (the 'Mediatisierung der Lebenswelt'), which allowed for the transition (in Europe) of late middle-age societies (staatlich organisierten Klassengesellschaften) into modern societies (ökonomisch konstituierte Klassengesellschaften; Habermas, 1981b:452).

12. Acquaintances, friends, family, neighbours, etc., belong to the private domain, while wider communities that are connected by means of newspapers, radio, television and other mass media belong to the public domain.

13. Habermas calls the phenomenon that the *increasing capacity* for communicative rationality leads to a level of system-complexity which results in a *withdrawal* of communicative rationality in certain realms, "the irony of enlightenment-processes in world history" (Habermas, 1981b:232; transl. CL).

14. This phrase is added by the author on the basis of an earlier, more precise, statement by Pijnenburg (1991:127).

15. In developing a classification of speech acts, Habermas adapts some of the ideas developed in 'speech act theory' (Austin, 1971; Searle, 1969). Austin makes a distinction between the 'locutionary act' (i.e. the physical act of making sound, moving one's tongue and mouth), the 'perlocutionary act' (i.e. the act of influencing another person's feelings, thinking and action), and the 'illocutionary act' (i.e. the act of posing a question, making a request, making a promise, giving an order, making a confession, etc.) (Habermas, 1981a:389; Koningsveld & Mertens, 1986:94). Habermas criticises the analytical validity of this distinction, and concludes that perlocutionary acts are a special sub-category

of illocutionary acts whereby illocutions are strategically applied to reach certain goals which are not made explicit in an interaction (for example to pose a question to embarrass someone) (Habermas, 1981a:395).

Thus, Habermas focuses on the speech act as an illocutionary act, which is built up out of a performative part (I [performative verb, e.g. 'ask you'], ...) and a propositional part (...., [proposition, e.g. 'to leave the room']. With the distinction between the objective, social and subjective claims inherent to speech acts in mind, Habermas proposes to group performative verbs into three categories, and (along the same lines) to distinguish between three basic types of speech acts. Ascertaining verbs (Konstative; e.g. to say, to predict, to argue) constitute 'ascertaining speech acts' (Konstative Sprechakte) which refer to a certain state of affairs, so that they imply an objective validity claim (truth) and can (in principle) be subjected to theoretical discourse.

Regulative verbs (e.g. to order, to advise, to request) constitute 'regulative speech acts' which refer to creating particular interpersonal relationships, so that they imply a social validity claim (normative rightness), and can be subjected to practical discourse. Finally, expressive verbs (e.g. to confess, to admit) constitute 'expressive speech acts' which refer to a person's inner experiencing so that they imply a subjective validity claim (authenticity), and can be subjected to therapeutic and aesthetic critique (Habermas, 1981a:439, 427ff, 448; Koningsveld & Mertens, 1986:96).

Communicative action usually involves all three different types of speech acts but regulative speech acts play a special role in that they serve the normative aspect in the coordination of human action, that is, regulative speech acts are by definition constitutive for communicative action (i.e. communicative coordination).

In addition to perlocutions (that is, strategically applied illocutions) Habermas distinguishes a second type of speech act as being inherently connected with strategic action, which he calls 'imperatives'. Imperatives manifest a speaker's will to make an other person act in a particular way (i.e. to realize a particular situation), and therefore have the general form: 'I want you to realize [situation X]'. Provided that the addressee knows how to instrumentally realize 'situation X', an imperative can be effective only if the speaker has the ability to exert certain positive or negative sanctions, and if this is recognized by the addressee (Koningsveld & Mertens, 1986:70).

According to Habermas, imperatives are to be distinguished from 'orders' (Befehle) which he sees as normatively authorized instructions, rather than as (self-interested) expressions of will that can (or cannot) be effectively sanctioned. Thus, while orders have a (criticizable) normative legitimacy and are followed on the basis of a (communicatively) rational motivation, imperatives are not criticizable as they are inherently connected with the operation of power, money and sanctions, and are followed on the basis of cognitive-instrumental considerations (Habermas, 1981a:434, 403ff; Koningsveld & Mertens, 1986:71-74).

16. In their purest form (that is, when they occur in isolation from other types of speech acts) ascertaining speech acts occur in a type of action that Habermas calls 'conversation' which is a type of deliberation on a situation definition in a hypothetical situation, i.e. it is not directly connected with the actual execution of action (1981a:438). Regulative speech acts in their isolated form occur in 'norm-guided action' (normgeleitetes Handeln), of which Habermas speaks when a 'solitary' actor develops a situation definition on the bases of shared norms, without directly interacting with others, while the purest form of expressive speech acts arises in 'dramaturgical action', where the main purpose of the actor is to represent oneself in a particular manner. Although Habermas still reckons these three purest types of ascertaining, regulative and expressive speech acts as forms of communicative action, he speaks of 'borderline cases' (Grenzfälle) of communicative action (Habermas, 1981a:438; Koningsveld & Mertens, 1986:112-116).

17. In addition to ascertaining speech acts, regulative speech acts, expressive speech acts and imperatives Habermas distinguishes between two more fundamental types of speech acts. "Kommunikative" are speech acts which reflexively refer to the process of communicative action itself, while "Operative" refer to the use of constructive rules (in mathematics, linguistics); that is, they are used in explicative discourse (Habermas, 1981a:436).

18. Even if the historic-hermeneutic sciences do not necessarily speak of 'general laws'.

19. Habermas stages psychoanalysis as the only science that inherently implies methodological self-reflection; that is, the process of psychoanalysis involves both nomological, hermeneutic and critical knowledge (Habermas, 1971:310; Habermas, 1973). As Giddens, in a discussion of Habermas, puts it: "What ties together and yet also balances the hermeneutic and nomological moments of the psychoanalytic encounter, Habermas says, is the emancipatory impulse which is its stimulus. If successful, psychoanalytic therapy translates unconscious processes, which cause the person to behave in ways not subject to his own voluntary control, into conscious modes of action which are subject to his rational mastery. Psychoanalysis has the critical task, through furthering the self-knowledge of the analysand, of liberating him from the push and pull of factors which drive his activity without the mediation of consciousness" (Giddens, 1976:59-60).

20. In other words, we can question the validity of Habermas' statement that: "Our first sentence expresses unequivocally the intention of universal and unconstrained consensus" (1971:314). Above mentioned quote quite legitimately leads Giddens to ask Habermas: "Why not say that our first gesture of recognition of another person promises a universal solidarity of human beings?" (1987:247).

21. Both issues of diversity and gender relations permeate agrarian politics, which clearly makes agrarian politics an arena in which normative issues are at stake. Apart from these issues, normative and ideological positions related to the market, property, entrepreneurship, inheritance etc. play an important role in economic and political domains.

22. In these approaches functionalism and symbolic interactionism are seen as complementary; their difference is considered to be no more than a division of labour between macro and micro sociology (Giddens, 1976:22). The implication of Giddens' structuration theory, however, is that the division between micro and macro sociology becomes rather unhelpful, and needs to be replaced by the division between social integration and system integration (Giddens, 1984:139).

23. Giddens distinguishes between discursive and practical consciousness, and unconsciousness. Discursive consciousness is described as: "What actors are able to say, or to give verbal expression to, about social conditions, including especially the conditions of their own action; awareness which has a discursive form" (Giddens, 1984:374). Practical consciousness, as distinguished from unconsciousness, is: "What actors know (believe) about social conditions, including especially conditions of their own action, but cannot express discursively; no bar of repression, however, protects practical consciousness as is the case with the unconsciousness" (Giddens, 1984:375). "The line between discursive and practical consciousness is fluctuating and permeable, both in the experience of the individual agent and as regards comparisons between actors in different contexts of social activity. There is no bar between these, however, as there is between the unconscious and the discursive consciousness. The unconscious includes those forms of cognition and impulsion which are either wholly repressed from consciousness or appear in consciousness only in distorted form. Unconscious motivational components of action, as psychoanalytic theory suggests, have an internal hierarchy of their own, a hierarchy which expresses the 'depth' of the life history of the individual actor" (Giddens, 1984:4-5).

24. Apart from structural properties, Giddens speaks of structural principles and institutions: "the most deeply embedded structural properties, implicated in the reproduction of societal totalities, I call *structural principles*. Those practices which have the greatest time-space extension within such totalities can be referred to as *institutions*" (Giddens, 1984:17).

25. Giddens distinguishes between several types of sanctions according to the resources that are mobilized in order to produce them. In relation to this he distinguishes between 'internal' and 'external' sanctions, which can both be further split up as being 'positive' or 'negative' with regard to the wants of the actor who is the target of sanction (1976:109).

26. Action (or agency) is defined by Giddens as: "the stream of actual or contemplated causal interventions of corporeal beings in the ongoing process of events-in-the-world" (Giddens, 1976:75).

27. Weber (1968:224) as cited by Giddens (1976:112) defines power as "the capacity of an individual to reach his will, even against the opposition of others".

28. Although, for example, Giddens discusses how the production of meaning is clearly connected with definitions of both (non-)compliance to a norm and/or appropriate sanctions for violating a norm, he does not mention how the production of meaning affects norms themselves.

29. According to Knorr-Cetina (1988:25), the person exists only "in and through communication and typification and not as initially given (a); as (discursively) extending beyond the individual organism and incorporating others within it, hence as not bounded by its biological skin (b); as consisting of a multitude of personas which vary with the occasion in which 'the person' is glimpsed (c); and as observable only in its fragmentation through a series of actions and behaviours (d). When conceived of with respect to its social and psychological functioning, the individual appears as a set of multiple identities which are insulated rather than functionally integrated into just one set of dispositions and beliefs which make up just one individuality."

30. According to Knorr-Cetina "methodological situationalism (...) challenges methodological individualism for the simplifying assumption that the locus of social action is the individual human being, and it challenges methodological collectivism for the equally simplifying and presumably related assumption that interview responses, or data in the form of reports and organizational records, constitute direct, valid sources of macroscopic inferences" (Knorr-Cetina, 1981b:15).

31. That is, they are not reflected upon in people's reasoning about the practices under consideration.

32. In illustrating the distinction between 'intentions' and 'reasons' Giddens draws upon an example from Schutz, and at the same time shows that the giving of reasons will often relate to 'commonsense': "'putting up an umbrella' is a characterization of an act; a man's intention in doing so might be expressed as 'to keep dry'; and his reason for so doing as the awareness that a suitably shaped object held above the head will keep the rain off. A 'principle of action' thus constitutes an explanation of why a particular 'means' is the 'correct', 'proper' or 'appropriate' one to achieve a given outcome" (1976:83-84).

33. This discussion is inherently connected with discussions about the concept of 'causality' in general. In relation to this Giddens argues that -in order to escape the 'freedom'/'causality' dichotomy- we need to make a distinction between 'agent causality' and 'event causality'. He concludes then that "'determinism', in the social sciences, then refers to any theoretical scheme which reduces human action solely to 'event causality'" (1976:85).

34. Motives, in Giddens' view, "refer to the *wants* which prompt action" (1976:85), which may or may not be accessible to their consciousness. Motives, then are closely related to emotions such as fear, joy, jealousy etc.. Thus, 'motivation' has to do with deeper personal layers that partly underlie actors' intentions and especially projects: "motivation is not as directly bound up with the continuity of action as are its reflexive monitoring or rationalization. Motivation refers to the potential for action rather than to the mode in which action is chronically carried on by the agent. Motives tend to have direct purchase on action only in relatively unusual circumstances, situations which in some way break with routine. For the most part motives supply overall plans or programmes -'projects', in Schutz' term- within which a range of conduct is enacted" (1984:6).
Interests, then, are defined by Giddens as "any outcomes or events that facilitate the fulfilment of the agents' wants" (1976:85).

35. Hindess criticizes conceptualizations in which "membership of a class or category defines an interest that exists independently of the practices of political parties and other organisations, and irrespective of whether the individuals concerned recognise it as their interest" (1986:113). Instead he proposes a much more contextual and negotiated interpretation of interests, whereby the "possibility of formulating particular interests and reasons for action" (1986:126) depends amongst others on the 'access' to particular discourses and other resources.

Chapter 6

Setting out for empirical investigation: the implications of the theoretical framework adopted

In this chapter I will conclude my theoretical exploration and clear the ground for more empirical forms of investigation.

In the chapters 3, 4 and 5 I have evaluated a considerable number of theoretical approaches with the aim of finding a framework that would: (a) allow us to understand the use and development of CT in the context of a complex social setting in which a *variety* of actors are *actively* engaged, and (b) help us to understand the social dimensions of knowledge, information, communication and rationality. It appeared that current approaches in informatics, information systems research and communication science fail to meet these criteria. Therefore, I concluded towards the end of chapter 4 that adequate conceptualizations in this respect might be found in sociology. In chapter 5, then, I have shown that a somewhat constructivist interpretation of Giddens' theory of structuration meets the criteria formulated at the outset in a more coherent and comprehensive manner than an actor-oriented sociology of rural development. Also, I have explained why Habermas' theory of communicative action falls short in this respect.

At this point, it becomes important to elaborate on the consequences of adopting my adapted version of Giddens' theory for studying the use and development of communication technologies. First, I will draw together some tentative conclusions on how the use and development of communication technologies must be theoretically understood when starting from this rather abstract theoretical framework (section 6.1). Second, I will formulate an overall problem statement for this study, recall the practical contributions that I envisage to make, and -keeping the theoretical framework adopted in mind- proceed to develop guiding questions on the basis of these (section 6.2). Finally, I will elaborate in section 6.3 on the methodological implications of my theoretical framework.

6.1 Conceptualizing the use and development of CT: preliminary theoretical propositions

I will present my conclusions with respect to the theoretical understanding of the use and development of CT as a set of interrelated preliminary propositions.

By stressing that *communication* is an inherent and crucial component of all social interaction, Giddens' framework reinforces my argument that (regardless of whether they are labelled as process automation, management automation or automated communication) computer-based systems or 'information technologies' are best conceptualized as *communication technologies* (proposition 1). Thereby, communication processes (including those that involve the use of communication technologies) are to be seen as negotiation processes, of which the outcomes (in terms of knowledge constructs and action generated by the actors involved) cannot be adequately understood without taking into account the political and normative interests that are at stake in these communication processes (proposition 2). That is, the use and development of communication technologies reflects actors' active efforts to make others draw upon particular rules and resources (embedded in mutual knowledge and ignorance), as connected with their (not necessarily discursive) wish to realize certain outcomes and projects, and/or (re)create specific structural properties (proposition 3).

These abstract conceptualizations have several more concrete implications for understanding the use and development of CT. It must be recognized, for example, that communication technologies inherently have different categories of users; not only is the official 'target-category' (e.g. 'dairy farmers') usually rather diverse (see section 5.1), but it can also be argued that other actors involved in the operation and development of communication technology (e.g. software developers, researchers, policy makers, information suppliers, etc.) can be validly termed 'users' as well. Thus, CT do not just have a software-technical 'user-interface', but may very well emerge at, constitute and/or (re)produce particular 'social interfaces'. Such social interfaces are defined by Long (1989:2) as:

> "critical points of intersection or linkage between different social systems, fields or levels of social order where structural discontinuities, based upon differences of normative value and social interest, are most likely to be found."

Understanding the use of communication technologies, then, is greatly enhanced when the social relations between the different categories (or groups) of users are analyzed (proposition 4). In such an analysis, it may appear that 'problems' related to the use and development of CT may be explained with reference to the fact that the various actors involved may constitute and/or belong to different '*epistemic communities*'. Such 'epistemic communities' can be described as networks of actors who have overlapping life-worlds, and thus draw upon mutual knowledge and mutual ignorance, as connected with adherence to similar grounds of belief, modes of rationalization and procedures for validating knowledge-claims (adapted from Arce & Long, 1987 and Knorr-Cetina, 1981). The 'problems' referred to above, then, may arise from specific actors' purposeful efforts to -with the help of CT- impose their views on the natural and/or the social world, and the ways actors should behave therein, on others (proposition 5).

In relation to this, I propose that it is misleading -for the analysis of the use and development of CT- to distinguish sharply between data, information and knowledge. This distinction is theoretically undesirable, for it mystifies the socially constructed nature of what might be better termed knowledge constructs of various levels of complexity and concreteness (e.g. numbers, parameters, texts, meanings, models of thought, life-worlds, etc.) (proposition 6). Furthermore, the socially constructed nature of knowledge implies that it is crucial to make context-sensitive and historical analyses of the rules of interpretation that are under negotiation in communication processes; in other words, 'the content' of what is being communicated is an important explanatory element for the way in which communication technologies are used (proposition 7). This may very well be a platitude, but, as I have shown in the previous chapters, it has been systematically ignored in informatics, information systems research and the field of computer-mediated communication in organizations.

Along the same lines it can be argued that the understanding of the use of a particular communication technology can be significantly enlarged if one conducts a historical study of the social interactions that have led to its emergence. In other words, for solving anticipation problems it can be very enlightening to know not only which types of anticipation problems exist, but also how they have come into being (proposition 8).

Although it is clear that communication technologies can have structural connotations (i.e. their designs incorporate certain rules and resources, and thereby a particular social 'code'), these 'structural characteristics' are both constraining and enabling. Although actors may not always be able to avoid drawing upon such rules and resources altogether, actors can be expected to creatively deal with such rules and resources, and thereby renegotiate the 'structural characteristics' of a particular CT. Thus, the introduction of CT can have consequences which -from the perspectives of the various actors involved- can be largely unintended (proposition 9).

Finally, it is misleading to conceptualize human actors as individual rational decision makers, and -in relation to this- look at communication technologies as artefacts that play a role therein. Actors are more adequately conceptualized as knowledgeable agents, who are continuously involved in the reflexive monitoring of their activities. An element of this reflexive process is 'reasoning' or 'rationalization'. This monitoring process (including rationalization) is an inherently social process in the sense that it is directly or indirectly influenced by others, and has political and normative dimensions. Communication technologies, then, have a potential to play a -never fully neutral- role in actors' reflexive monitoring of action (proposition 10).

6.2 Problem statement, and guiding questions for arriving at practical contributions

In line with above presented theoretical propositions, the overall problem statement addressed in this study has evolved into:

> To what extent can the limited success of communication technologies in primary agricultural production be explained by, on the one hand, the social dimensions of CT-development processes themselves, and, on the other, a neglect for the social dimensions of knowledge, information, communication and rationality on the side of those who are involved therein?

When assuming that 'limited success' always implies a certain friction or type of 'anticipatory misfit' (see section 4.2) between the communication technology and the context in which it is introduced, this 'theoretical' problem statement can be reformulated into:

> To what extent do anticipation problems originate from: (a) the social nature of CT-development processes, and (b) insufficient recognition of the social dimensions of knowledge, information, communication and rationality.

The overarching question that must be answered in my 'practical' line of argumentation (see chapter 1), then, can be phrased as:

> Can an understanding of: (a) the social nature of CT-development processes, and (b) the social dimensions of knowledge, information, communication and rationality, contribute to a more satisfactory use and development of communication technologies in primary agricultural production, and if so, how? That is, how can an understanding of such social dimensions help to improve the anticipatory nature of communication technologies?

Reflecting on the dominant discourse on problems and solutions with respect to communication technology use and development in primary agricultural production, I have already identified a number of possibly useful contributions in chapter 2. At this point, I will narrow the scope for empirical investigation by formulating a number of specific guiding questions which are inspired by this discourse, these envisaged practical contributions, the theoretical framework adopted, and/or the problem statement formulated above. These guiding questions will play an important role in selecting the empirical realms that I will plunge into, and will give focus to my explorations therein.

Below, I will repeat -and sometimes rephrase slightly- the practical contributions arrived at in chapter 2, and present the guiding questions in relation to these.

(Practical contribution 1)
A methodology for making empirically-based classifications of farmers and horticulturists that are relevant for CT-development.

(1) What methods are used in order to classify the existing diversity in farming, and what is the social rationale of these classification practices?

(2) To what extent do the resulting classifications reflect the social nature of farming?

(3) Do the dimensions used for classification help to shed light on different socially constructed rationalities, communication patterns, CT-use or knowledge networks?

(4) How important is it to anticipate diversity, and what is the scope for standardization of agricultural communication technologies in this respect?

(5) Is it possible to arrive at relatively stable classifications?

(6) Which classification methods and dimensions for classification are relevant to the development of communication technologies.

(Practical contribution 2)
Criteria and ideas for the design of CT, and the organizational arrangements in which they are embedded, that facilitate a balanced integration of knowledge originating from different epistemic communities.

(7) Which types of communication technologies exist in practice, which social 'codes' are built-in to these, and what is the scope for incorporating knowledge from different epistemic communities in them?

(8) How important is it (in the context of improving the anticipatory nature of communication technologies) that an integration between knowledge from different epistemic communities is achieved?

(9) How do communication technology developers deal with integration of 'scientific' and 'non-scientific' forms of knowledge, and why; i.e. what are the social dimensions of their practices in this respect?

(10) What are the consequences of increasing formalization of knowledge, and/or the growing complexity of models implemented in agricultural communication technologies, for bringing about an integration between knowledge from different epistemic communities?

(11) How can we, in a particular social context, arrive at valid criteria that communication technologies (including the organizational arrangements in which they are embedded) should meet in order to both increase their anticipatory nature in general, and to improve the integration of different types of knowledge in particular?

(Practical contribution 3)
Insight in how extension workers can contribute to the development and use of appropriate CT, and in the arrangements needed to realize the potential contribution of extension workers.

(12) What role(s) do extension workers presently play in the use and development of agricultural communication technologies, and why; i.e. what are the social dimensions of their practices in this respect?

(13) How important is it, from the farmers' point of view, that extension workers are involved in supervising the use of communication technologies?

(14) What criteria should communication technologies (including the organizational arrangements in which they are embedded) meet in order to adequately anticipate extension processes in a particular context?

(Practical contribution 4)
To develop an empirical and inductive methodology for identifying information needs that can be expected to have a long-term relevance for particular groups and/or categories of farmers.

(15) How do information needs emerge in social interaction?

(16) How stable are information needs?

(17) What methods are applied for the identification of information needs, what is the social rationale of these practices, which bottlenecks exist for whom, and what alternative methods can be developed on the basis of my theoretical framework?

(18) How important is it to identify information needs in order to improve the anticipatory nature of communication technologies.

(Practical contribution 5)
An assessment of: (a) the types of user-research and user-influence that are required in agricultural CT development; (b) the ways in which they can be incorporated into CT-development methods; and (c) the conditions under which user-research and user-influence are likely to be effective.

(19) What is the place and nature of 'user-participation' and 'user-research' in communication technology development methods that are currently applied in agriculture? What is the social rationale of these practices, and which bottlenecks exist for whom?

(20) How important are 'user-research' and 'user-participation' for increasing the anticipatory nature of communication technologies in agriculture?

(21) What alternative methods can one think of on the basis of my theoretical framework, and how can they be integrated in communication technology development processes?

(22) Under what social conditions can 'user-participation' and 'user-research' be effective.

In one way or another, most of the questions listed above already more or less explicitly refer to the role that social scientists can play in developing suitable classifications of users, design-criteria, organizational arrangements, methods of user-research and user-participation, etc. Even if answering some of these questions may eventually lead to somewhat unconventional recommendations, I believe that -if I would stick to just answering these questions- I would only marginally contribute to the conventional practice of communication technology use and development. This because it would imply that no justice is done to my theoretical framework in that too little attention is paid to the social scientist as a social actor. As I have argued earlier (see sections 4.2 and 5.1) an increased understanding of the social nature of communication technology use and development will -in order to be helpful for bringing about desired social change in a specific context- need to be accompanied by an understanding of the role of the social scientific researcher therein. Therefore, a few additional questions must be addressed:

(23) What are the social dimensions of social scientific research activities in relation to the development of communication technologies?

(24) What is the social nature of the outcomes (anticipation problem identifications, classifications, methods, etc.) produced by the social scientist, and what are the implications of these for processes of social change?

(25) How can social scientific research activities, and in particular the choosing of research questions, best be organized in order to contribute to desired social change, and how can 'desired social change' be defined?

(26) What organizational arrangements are necessary in order to allow for the type of social scientific research described above?

6.3 Methodological implications

In this section, I will discuss several methodological implications of the theoretical framework adopted. First, I will highlight the methodological guidelines that follow logically from my theoretical approach. Second, I will discuss the actual research methods used. Following that, I will elaborate on the relationships between the preliminary propositions, guiding questions, the research methods, methodological guidelines and case-study selection. Finally, I will discuss several aspects related to the role of the social scientific researcher in the production of knowledge and social change.

Methodological guidelines or empirical focus

As argued by Van Velsen (1967), and in line with Kuhn's (1970) and Feyerabend's (1975) claims with regard to the theory-ladenness of observations, there is a close relationship between the researcher's theoretical approach and the type of empirical material collected. Starting from my modified version of Giddens' theory of structuration a number of guidelines can be identified for focusing the empirical investigations. In doing so, I am not only inspired by Giddens' (1976) 'new rules of sociological method', but also by the methodological views of others, such as authors within the Manchester school of social anthropology (i.e. Gluckman, 1961; Van Velsen, 1967), representatives within an actor-oriented sociology of rural development (Long, 1989; Long & Long, 1992), and by constructivist thinkers within the sociology of knowledge and science (Callon, 1986a; Callon et al., 1986; Knorr-Cetina, 1981). Below, I will summarize some of the principles which have guided me in conducting empirical research.

First of all, the theoretical framework urges me to have a special interest in the *day-to-day practices* of actors which relate directly or indirectly to the use and development of communication technologies (guideline 1). It is through such practices that actors simultaneously produce and reproduce rules and resources, and thereby the structural properties that characterize the context in which they operate. Therefore, such social practices are to be studied in a *contextual* manner; that is, understanding such practices requires an analysis of their social, historical and spatial dimensions (guideline 2).
Social practices emerge in social interaction and therefore they usually involve and/or refer to a variety of actors. In many cases social practices have a relatively unproblematic and routine-like nature. However, for understanding processes of social change, and even for increasing our understanding of routine-like practices, it is important to study social action

that emerges in more conflictive situations (Van Velsen, 1967:146); for example, at what Long (1989) calls *social interfaces* (guideline 3).

As is implied by the very notion of social interface (see earlier quoted definition in section 6.1), the actors involved in interface situations can be expected to hold *diverging interpretations* (of various kinds) in relation to them. In order to increase the understanding of social interfaces related to the use and development of communication technologies, it is important to investigate, and give voice to, such interpretative differences (guideline 4). Thereby, it is important to analyze how different interpretations at social interfaces are intertwined with *human agency*, or -more precisely- with a diversity of actors' *strategies*, *intentions* and *projects*. That is, it is important to analyze how actors -in relation to and/or with the help of communication technologies- actively construct 'reality' (guideline 5).

A possibly useful entry-point for studying different interpretations, strategies, intentions and projects, are people's *rationalizations* with regard to their (past and/or prospective) practices and actions (guideline 6). When dealing with rationalizations, it must be recognized that it is problematic to see 'reasons' as causes for action (see section 5.3), and that there may be differences between what people say and what they do. Nevertheless, it can be argued that actors' verbal statements (and discourses in general) are forms of social practice and action (see Van Velsen, 1967:134), and moreover, that they are as close as one can get to actors' interpretations. Therefore, it is equally significant to record the rationalizations that people make, as it is to observe the social actions and practices that they engage in. The existence of contradictions between different types of action/practice (e.g. between what people 'say' and what people 'do'), or even blatant 'lies' that respondents express, are not to be seen as mere methodological problems, but rather as having an informative capacity of their own that increases our understanding of the complexities and contradictions of social life (see e.g. Nencel, 1992).

In exposing actors' rationalizations, the researcher must take an *agnostic* attitude towards the rationalizations presented by the different actors; that is, the observer remains impartial towards the reasons put forward, and refrains from censoring the actors' interpretations of practices, people and society (guideline 7; see also Callon, 1986:200). Furthermore, in order to explain phenomena related to the use and development of communication technologies it is important -in the context of different actors' practices, actions and rationalizations- to look for *unintended consequences* of action and *unacknowledged conditions* for action (guideline 8).

Social structure can be seen as recursively organized rules and resources. For understanding social interactions related to the use and development of communication technologies, it is therefore important to analyze the *production* and *reproduction* of (repertoires of) *rules of interpretation*, *normative rules* and *resources* therein (guideline 9). Thereby, the constraining and enabling dimensions of social structures can be best understood by exposing actors' more or less effective attempts to create *space for manoeuvre* at social interfaces related to the use and development of communication technologies (guideline 10).
Since normative rules and resources can eventually be regarded as rules of interpretation as well, it is -in more general terms- important to study how particular interpretations (including Knorr-Cetina's 'summary representations') are selected, negotiated and legitimized in a particular context (guideline 11). A suitable vocabulary for describing and analyzing these processes may be derived from the 'sociology of translation' (Callon, 1986; Callon et al.,

1986). The central concepts in this approach are *translation* and *enrolment*. Actors enrol other actors when they -in one way or another- acquire (or are seen as having acquired) the legitimacy or ability to speak on their behalf and/or with their support. Thus, enrolment entails putting forward a specific interpretation of the definition and distribution of roles within a network of actors, and can at the same time be seen as a strategy to make others accept a certain interpretation of 'reality'. The term 'translation' refers to the various methods and strategies actors use to enrol others. Callon et al. (1986:glossary) mention three: (a) attempts to define and influence *roles*, *scenarios* and *role distributions*; (b) strategies by means of which actors present themselves as indispensable to others (i.e. the creation of "a geography of *obligatory passage points*"); and (c) efforts to *displace* others in line with a particular scenario[1].

This vocabulary offered by the sociology of translation can, even if I do not always agree with the way in which the concepts have been used by Callon et al.[2], serve as a useful set of sensitizing concepts (rather than as a straitjacket) in my empirical explorations.

Since the natural and material world can only be understood and/or assigned with meaning in social interaction, it may -following Callon (1986a)- indeed be helpful to regard these as entities that can be enrolled as well. In their interactions with others, actors do indeed make claims about (i.e. they 'speak on behalf of') the material and natural world in a somewhat similar fashion as they make claims about human actors. However, I would not go as far as Callon (1986a) in claiming that natural and material phenomena -like human beings- can be fruitfully seen as 'social actors', since the capacity of such entities to enrol strategically others and/or to oppose the claims made about them (i.e. the nature of their agency) seems to differ fundamentally from that of human beings. Nevertheless, and especially in the world of agriculture, it can indeed be useful to analyze the ways in which the use and development of communication technologies is intertwined with the *enrolment and translation of material and natural entities* (guideline 12).

On case-studies and the methods applied in them

Not surprisingly, the methodological guidelines outlined above, and the exploratory character of my study, leads me to adopt a case-study approach. It is only through case-studies I can actually hope to display, at least to a certain extent, day-to-day practices, different interpretations, rationalizations, projects, enrolments, etc., in a contextual fashion. More particularly, I will take what Van Velsen (1967) calls 'the extended-case method' or 'situational analysis' as my overall model of research.

Van Velsen (1967:140) and others (e.g. Gluckman, 1961:7; Long, 1989:251) have stressed that the presentation of case-study material (for example records of actual situations and behaviour and/or detailed ethnography) should not serve as an anonymous "apt illustration" of the social scientist's abstract theoretical argument, "but as a constituent part of the analysis" (Van Velsen, 1967:140). In this study, I take this to mean that -although at a certain level of abstraction the presentation of a case-study is always an 'illustration' for something- specific empirical accounts should not be lifted out of their relevant context (e.g. a complex situation, a specific personal history, etc.), and that my interpretation of these should in one way or another be *grounded* in the interpretations or 'theories' that are expressed by those directly involved.

In itself, a case-study approach does not inherently imply the use or exclusion of specific research methods and techniques. However, it is clear that, given my theoretical framework and the subsequent adoption of the extended-case method, I will grant primacy to qualitative research methods, or, as Knorr-Cetina (1981:17-20) puts it, to 'sensitive' rather than 'frigid' methodologies. Whenever I use quantitative methods, therefore, I see it as my duty to trace back the interpretation of quantitative conclusions to the perspectives of the actors concerned. Similarly, and following suggestions from Elias & Scotson (1976), I will at several points in this study let 'sociological significance' prevail over statistical significance.

While conducting case-studies I have applied a wide variety of different research techniques. In my view, the choice of certain methods in a particular case-study is a contextual phenomenon that is connected with the (equally contextual) 'choice' of the case-study's boundaries. Therefore, I will discuss the details and rationale of the methods adopted at the start of the presentation of each case-study. Below, I will in more general terms describe the most important research methods and techniques that were used.

Qualitative content analysis

For several case-studies I have -in order to get to grips with the relevant context- conducted forms of qualitative content analysis. In an effort to place the case-studies themselves into context, I have studied a number of policy documents and evaluation studies related to the use and development of communication technologies in agriculture (chapter 7). In addition, I have in a particular case-study analyzed a considerable amount of project documentation, minutes, correspondence, etc., as one of the sources for reconstructing the development processes that have led to the emergence of particular communication technologies (chapter 10). Finally, I have examined the contents and characteristics of several communication technologies.

Semi-structured and in-depth interviews (qualitative interviews)

In all case-studies, I have conducted semi-structured and in-depth interviews. In these interviews, there was usually a previously prepared list of open questions and/or themes (that is, without pre-structured response categories). Frequently, the answers given gave rise to new questions on the side of the researcher, and respondents were encouraged to elaborate on the given answers, bring up new issues, and raise matters that at first sight might have seemed irrelevant to the original question. Hence, the order in which the previously prepared questions were asked, and the way they were phrased differed. In this manner, a 'dialogue' between researcher and researched was created. Even if I recognize that the notion of a 'dialogue' can have misleading connotations (i.e. the suggestion that one can create a 'power-free' exchange between 'equals', or conversely, the idea that it is the researcher who is in charge of such an interview, and who 'grants' an opportunity to speak out to the researched) I still think that maintaining a 'dialogical ideal' (Schrijvers, 1991) is helpful when the aim is to explore actors' life-worlds, projects, etc.

Structured interviews (quantitative interviews)

In combination with more qualitative interview techniques I have at some points made use of more 'traditional' survey techniques. The closed questions in these structured interviews were always based on in-depth interviews conducted earlier.

Social mapping
Some of the quantitative and qualitative techniques I used were especially aimed at arriving at a 'social map' (or classification) of farmers.

Participant observation or 'sharing space'
In some case-studies, I have attended meetings which influenced the course of action of particular communication technology development processes. In addition, I have been present at interactions between farmers and extension workers in which communication technologies played a role. Finally, I have frequently sat down with farmers behind their computer (or computer print-outs), and observed and participated in an effort to make sense of whatever the communication technologies generated. Following Nencel (1992), and in order to express the multi-facetted character of such interactions between 'researcher' and 'researched', I prefer to use the term 'sharing space' instead of 'participant observation' for these research experiences.

Network analysis
In several studies I have carried out some simple forms of network analysis. With the help of both quantitative and qualitative interview techniques insight was gained in the use and importance of various sources of information and knowledge.

Feedback sessions
Towards the end of the research period, I have for most case-studies organized one or more sessions in which part of the researchers' interpretations and conclusions were presented and discussed with particular actors. The idea behind such sessions was, that they would be useful in inter-subjectively correcting and/or validating the researcher's interpretation. Obviously, not all conclusions arrived at lend themselves to such discussions, partly because some would have required considerable elaboration on abstract theoretical themes, whereas others have only emerged long after the case-study had been 'closed'.

The relationship between preliminary propositions, guiding questions, methods, empirical focus and case-study selection

In this book, I have so far developed a theoretical perspective, identified preliminary theoretical propositions, formulated prospective practical contributions and guiding questions, deducted methodological guidelines (i.e. an empirical focus) and chosen certain research methods. At this point it may be useful to briefly recapitulate how these are intertwined, and connected with case-study selection. Thereby, it is useful to distinguish between the 'practical' and the 'theoretical' line of argumentation.

In the 'practical' line of argumentation, I have identified five *prospective practical contributions* that I would like to make (chapter 2). I arrived at these primarily on the basis of a (theoretically and empirically informed) critical analysis of the dominant discourse on problems and solutions in relation to the use and development of communication technologies in primary agricultural production. In section 6.2, I have -inspired by this discourse and my theoretical exploration, translated these prospective contributions in a number of *guiding* *questions*. These prospective practical contributions and guiding questions have served especially as important criteria for the *selection of case-studies* (even if I must admit that -in actual practice- some of the guiding questions emerged only after I had engaged in such a case-study already). Entering a case-study usually involved a negotiation process[3] between the different actors involved, which, amongst others, resulted in one or more 'problem statement(s)' on the basis of which the respective actors agreed to cooperate. Obviously, on the side of the researcher an important criterion for engaging in a case-study was that the 'problem statement(s)' and research setting allowed room for including at least some of the guiding questions listed in section 6.2.

In relation to the 'theoretical' line of argumentation, the elaborations in chapter 2 resulted in the formulation of two criteria that an adequate theoretical framework for understanding the use and development of CT would have to meet. In chapter 5, I have eventually identified a rather abstract theoretical framework that meets these criteria. On the basis of this framework I have formulated several *preliminary theoretical propositions* which refer more specifically to the theoretical understanding of the use and development of CT. The theoretical framework adopted is in many ways a formal meta-theory, which proposes that a more down-to-earth understanding must be rooted in the experiences and life-worlds of the actors that are studied. In that sense, the consequences of this theoretical framework are mainly methodological. Therefore, I would like to explore the validity of the theoretical framework by establishing the relevance of the *empirical focus* (i.e. the methodological guidelines) that can be logically derived from it. Only if my empirical focus does indeed increase both our understanding of the use and development of communication technologies, *and* our capacity to make practical contributions (i.e. answer the guiding questions) I will conclude that (elements of) the theoretical framework, and/or (some of) the preliminary theoretical propositions are plausible and relevant.

Clearly, the prospects for carrying out research in conformity with the methodological guidelines was also a principal consideration for *selecting case-studies*.

In line with the methodological guidelines, the extended-case method was adopted as the overall model of research. Therein, the concrete *research methods and techniques* have been chosen in a rather contextual fashion, whereby primacy was given to qualitative (that is, interpretative or sensitive) techniques.

Reflecting on the researcher as a social actor

I have already stressed the importance of reflecting on the role of the social scientific researcher as a social actor (see sections 4.2 and 5.1). In this section I will discuss two different aspects in this respect. First, I will reflect on the researcher as a social actor in the production of knowledge and text, and following that I will pay attention to the role of the researcher in processes of social change (i.e. the 'interventionist' dimension of doing (actor-oriented) research). It can be argued that it is somewhat artificial to distinguish between the two, since the production of knowledge and text itself can already be seen as 'social change'. Indeed, this is correct to the extent that the production of knowledge implies in fact the creation of rules of interpretation; that is, potential elements that -through the 'double hermeneutics' of social scientific knowledge- can be drawn upon in the (re)production of structural properties of social systems. However, I still think that it is useful to distinguish between the researcher's contribution to the production of rules of interpretation and his or her role in the creation of structural properties on the basis of these; not least because so far actor-oriented sociologists have paid considerably more attention to the former than to the latter.

The researcher and the production of knowledge and text

My theoretical framework leads me to argue that doing research means engaging in social interactions, and that the nature and outcomes (e.g. knowledge and text) of these cannot be understood without taking into account the agency, projects, interests, normative evaluations and even feelings (Nencel, 1992) of not only the researched, but also of those on the side of the researcher. Thus, authors with an actor-oriented inclination have in their writings tried not only to present and give voice to the researched as historically and socially situated agents, but they have also deliberately avoided to write themselves 'out of the text' (see e.g. Van der Zaag, 1992; Brunt, 1992; De Vries, 1992; Nencel, 1992).

In my study I will at several points elaborate on how my interpretations as researcher, and my attempt to communicate these through text, are connected with my 'personal' interests, projects, evaluations, interests, etc. Before starting, it must be noted that the way I envisage the relation between knowledge and text may conflict with the ways structuralist writers such as Derrida (1976) have conceptualized it. Although I recognize that texts 'have' a certain 'autonomy' in the sense that those that read them construct their own meaning (i.e. texts do not have an unequivocal informative capacity, see section 4.2), I find it -unlike Derrida- less useful to separate 'writing' from 'communication', and thereby disconnect the text from its author (see also Giddens, 1979:40-45). In my view, a text remains an attempt of an author to communicate particular meanings to a more or less articulate audience. Moreover, the meanings constructed out of a text by a reader have to be understood in the context of the social relationship between the author, the reader and others. Even if the relationship between author and reader can be very indirect, and mediated by the translations and enrolments made by others, I see no fundamental difference in this respect between communication processes involving written media, and those involving others (e.g. radio, face-to-face communication, computer programs, etc.).

Thus, both knowledge and written text, as constructed by the researcher, are to be seen as outcomes of negotiation processes between the researcher and other actors (e.g. respondents, colleagues, opponents, promoters, etc.) and/or different 'personas' within the researcher. These negotiation processes may either actually take place in a 'physical' manner, but can also unfold in a more virtual manner; that is, as a mental process within the researcher, who either anticipates discussions with other actors and/or 'negotiates' between the different personas which he or she constitutes in different social contexts or networks.

In chapter 1, I have -in relation to the foregoing- already touched on some broader social dimensions of the research, which may help to clarify in the context of which 'negotiation processes' this study was shaped, and which interests, projects, and feelings of the researcher were of importance.

The researcher and the production of social change
Different models have been developed with regard to the role of social scientific researchers in processes of social change. In 'hard' systems thinking, for example, social scientists emerge as social engineers, whereas in the 'soft' systems approaches they are seen as facilitators in reaching consensus and/or accommodation (see sections 3.3 and 4.2). Others would like to see social scientists as participants in processes of planned intervention (Scott & Shore, 1979), as critical commentators (Box, 1981), or as political and/or emancipatory activists (Klein, 1982; Huizer, 1973).

It is not immediately clear how one must conceptualize the role of social scientists in helping to achieve desired social change on the basis of my theoretical framework. In my view such a role implies at least going beyond the production of new interpretations and text. In practice, even actor-oriented researchers indeed go, or cannot avoid going, beyond this point. However, I have argued that so far they have neglected this aspect, and have refused to reflect on it systematically. Hence, they have not provided us with a clear idea on how their approach can be used to help solve 'practical' problems other than through relying in a rather gambling-like manner on the 'double hermeneutics' of social scientific knowledge (see sections 4.2 and 5.3). My wish to capitalize more effectively on this particular characteristic of the social sciences, is reflected in the last four research questions presented in section 6.2. Thus, the role social scientists can play in processes of intervention (in this case related to communication technology development and use), while starting from actor-oriented theoretical frameworks and methodological principles, is one of the important themes in my empirical explorations.

In relation to each case-study, therefore, I will explicitly reflect on my own role in the production of 'desired' social change. This involves amongst others examining the interrelations between the researcher and the researched, analyzing the social changes that emerge as a consequence of the research, reflecting on whether or not, and for whom, these changes can be labelled as 'desired', etc. On the basis of a comparative analysis of the different case-studies in this respect, I hope to generate more insight as to how my theoretical perspective and methodological principles can be used in order to contribute to the realization of particular social changes. In Giddens' terms: I hope to engender ideas not only on how social scientists can generate 'new' rules of interpretation, but also on how they can contribute to their effectuation (i.e. the acting of actors on the basis of them), and thereby to the emergence of particular structural properties.

Notes

1. The elementary form of translation is '*interessement*' "which involves one entity attracting a second by coming between that entity and a third". In the realm of science interessement takes the form of '*problematization*', that is, the translation of a particular problem into one or more scientific problems, whereby the assumption that one needs to solve the scientific problems in order to solve the 'real' problem implies in fact an attempt to create one or more obligatory passage points (Callon et al., 1986:glossary).

2. In case-studies presented by Callon (1986a, 1986b), for example, the concepts are used predominantly from the perspective of scientists. In contrast to Callon's agnostic ideal, this means in fact that many actors are silenced, which results in fact in an over-exaggeration of the power of

scientists vis-à-vis others. Thus, I would plea for a more multidimensional perspective by means of an analysis of how the different actors involved attempt, succeed and/or fail to enrol others for their particular projects.

Another point of critique is that Callon (1986a) seems to portray his case-studies in terms of logical order of stages (i.e. problematization, interessement, enrolment, mobilization and dissidence), whereby 'enrolment' becomes confusingly depicted as a particular stage in a rather continuous long-term process. Instead, I would like to see enrolment as something that is inherently connected with micro-interactions, whereby it is of course of great interest to see how different enrolments are linked through time and space.

Third, although I am sympathetic towards Callon's methodological principle (derived from Bloor, 1976) of generalized symmetry (i.e. the goal "to explain conflicting viewpoints and arguments in a scientific or technological controversy in the same terms" (1986a:200), I think that this holds especially for the more abstract theoretical interpretation of a case-study. In my view, however, the presentation of any case-study is incomplete if the *variety* of 'theoretical' explanations and concepts of the actors themselves do not come to the fore. The principle of 'generalized symmetry', therefore, should not be used as an excuse to ban ethnographic material from a scientific text, which -because of its virtual absence- I suspect to be the case in Callon's studies.

3. In this negotiation process, the boundaries of a case-study were established. The interests and questions of the researcher clearly played a role in drawing boundaries, but also the 'researched' had an influence in the sense that they could deny access to certain realms, and pose conditions for their cooperation. Similarly, other practical, financial and institutional circumstances had consequences in this respect as well (see the discussion of 'the researcher as a social actor' towards the end of this chapter).

Part II

EMPIRICAL INVESTIGATIONS

Chapter 7

The broader context of communication technologies in agriculture: institutional developments, the present state of the art and mainstream development methods

In chapter 2, I have made a start with 'setting the scene' by discussing critically the explanations and solutions that are currently proposed with regard to the limited uptake of communication technologies in Dutch primary agriculture. In this chapter I will focus more on the CT themselves, and on how they have emerged over time. First, I will give an overview of the institutional developments and efforts which have been important in shaping the present state of affairs (section 7.1). I will then continue (in section 7.2) to present and interpret some quantitative figures on the use of CT by farmers. Building on my theoretical framework, I will also attempt to develop an unconventional classification of the types of CT that have been developed so far (section 7.3). In section 7.4, then, I will discuss some of the dominant methods of communication technology development that have been applied in agriculture.

With the exception of section 7.3, above mentioned parts are mainly of a descriptive nature. The main sources on the basis of which these sections have been written are policy documents, evaluation reports, and literature on agro-informatics and software development. The active production of such written material, in my view, is part of social practices (or takes place in the context of these) and can hence be a useful entry point for an investigation of the broader social context. This is especially so since one might expect that such texts incorporate 'summary representations' (see section 5.3). Since I will in this chapter consider the written artefacts to be my empirical material, I have to sometimes resort temporarily to the therein commonly used representations, interpretations, concepts and figures, even if -at an earlier or later stage- I refer to them as being problematical.

In the final section of this chapter, I will analyze the material presented in more theoretical terms. I will identify a web of interrelated classifications that agro-informaticians frequently draw upon. I will propose that these classifications can indeed be regarded as inherently social summary representations, which are drawn upon in the (re)production of structural properties that characterize the domain of agro-informatics. In relation to this, I will also discuss issues of intentionally organized ignorance and self-referentiality. In this manner, I hope to demonstrate the significance of my theoretical perspective for both theorizing about this broader 'macro-context' and furthering our understanding of the use and development of CT. At the same time, I hope to provide the reader with some understanding of the broader context in which the later presented case-studies are embedded.

7.1 Institutional efforts to stimulate the use and development of communication technologies in Dutch primary agriculture

The possibilities to support farmer decision making with the help of computers have -in the last 15 years- received increasing attention, especially from research, extension and policy institutions. In the early days, researchers, subject matter specialists or even extension workers embarked on developing CT in a rather incremental manner. In some cases, such CT merely performed rather simple calculations[1]. More complex CT often originated from the availability of databases and/or computer programs that had been originally developed for other purposes. It seemed fairly easy to develop programs with an advisory nature on the basis of, for example, databases of farm accounts, crop simulation models, linear programming techniques, etc.

In many cases, the first prototypes of such CT were the result of largely individual 'projects' and/or hobbies, in which a considerable amount of spare time was invested. Only at a later stage did the employers of these individuals become interested in their achievements, and did they feel an urge to capitalize on the investments that had already been made. Often, it was then considered necessary to take up the development activities in a more systematic way and involve more people, such as farmers, researchers, extension workers, information analysts and professional programmers. In this respect Hamilton's (1990) Australian case-study on the development history of WHEATMAN is illustrative.

On government investments in CT and their legitimation

In the early eighties, public institutions and farmer organizations felt a need to embark on a more systematic approach to the development and stimulation of CT in agriculture. By then, increasing problems and worries with regard to the compatibility of both hardware and software had arisen, and despite increasing confidence in the potential of computer supported decision-making, the uptake and development of suitable CT had appeared slow. In 1984, therefore, the Ministry of Agriculture and Fisheries (MLV) linked up with special informatics stimulation programmes issued by the Ministry of Economic Affairs and the Ministry of Education and Science, and presented its own Informatics Stimulation Plan (INSP-LV; MLV, 1984).

The establishment of such programmes as INSP (in total 1197 million guilders) can be observed in many countries, and has gained extra impetus after the Japanese government announced its Fifth Generation Programme in 1981 (Ministry of Economic Affairs, 1988; Arnold & Guy, 1986[2]). Many governments saw this programme as a major threat to their competitive position. Furthermore, it can be added that -due to the history and particularities of the sector- there is a long history of state intervention and stimulation activities in Dutch agriculture, amongst others in the field of research and technology development (Koning, 1982). By now -and in addition to infrastructural advantages- the so-called 'knowledge intensive' character of the sector is generally seen as a major competitive advantage, whereas in terms of climatological conditions, inheritance regulations, prices of land, economics of scale, environmental costs, etc., the sector is at a disadvantage vis-à-vis other countries. Not surprisingly, therefore, the 'success story' of Dutch agriculture (a small overpopulated country and nevertheless the second largest exporter of agricultural goods in the world) is commonly explained in terms of the synergetic interaction between agricultural policy, research, extension and education. In relation to this, a strong belief in the blessings of science and technology can be found throughout the agricultural sector. In this context, government investments in agricultural CT can be seen as a continuation of longer standing policies and beliefs.

The Informatics Stimulation Plan for agriculture originally covered over a five year period. During this period, 228 million guilders were distributed between agricultural education, research, university infrastructures, the market sector and the Ministry itself, including the agricultural extension service (Ministry of Economic Affairs, 1988). Originally, a total of 25 million guilders was allocated to the market sector, which consists of both primary agriculture and agricultural services, trade and industries. Later on an additional 16.3 million guilders were earmarked for the market sector (CLO, 1988:26)[3]. This amount of money may seem relatively low, but it must be noted that a considerable amount of the research activities (with a total allocation of 92 million guilders) was indirectly aimed at supporting the market sector as well. Furthermore, public and private institutions have invested in additional resources as well, since project subsidies amounted to between 50 and 60 percent of the costs made.

As I have discussed earlier on (see chapter 2), it is common usage in agro-informatics to distinguish between *management automation*, *process automation* and *automated communication* or information delivery. The overall goal for the INSP-LV, especially with regard to the market sector, was to improve the competitive position of the sector as a whole (MLV, 1984). To this end, the programme was explicitly directed at stimulating management automation and automation of information delivery in primary agriculture (MLV, 1984; Klink, 1991a). In the light of these priorities, however, it is quite striking that there was little elaboration in the INSP-LV report and related policy documents on *how* exactly farmers were expected to benefit from management automation and automated information delivery. It seemed to be merely taken for granted that both fast registration and processing of on-farm information and automated information delivery would somehow result in the saving of inputs, increased speed of reaction, and better insight in the economic situation of the farm (MLV:7-8).

In contrast to these rather unspecific expectations with regard to *management* automation, it was suggested that *process* automation would help farmers to come closer to achieving theoretical production limits (e.g. by means of climate control), increase labour productivity, improve both the conditions of labour and product quality, and reduce input levels and environmental degradation (MLV, 1984:7). Furthermore, for the *sector* as a whole (and especially trade and industry) it was proposed (MLV:13) that considerable competitive gains could be realised through computer supported Integrated Chain Management (ICM) (Blokker, 1991); that is, a more efficient streaming of goods through the agricultural production chain (i.e. fewer stocks, better planning, more homogeneous input and output, etc.).

At this point it is worthwhile to take a seven year leap forward. In an advisory report for the Ministry of Agriculture, Fisheries *and* -newly added- *Nature Conservation* (MLNV) concerning the post-INSP-LV policy, Klink (1991a) stresses the importance of management automation at farm level as a precondition for achieving the general aims of the new agricultural policy (as reflected in SNL; MLNV, 1989). More precisely, it is argued that both an increase of agricultural end product quality (which would presumably result from

Integrated Chain Management) and the fine-tuning required for sustainable agricultural production systems, are impossible without registration and processing of data at farm level. In an even more explicit plea for the continuation of informatics stimulation subsidies, the three main farmers' unions reinforce Klink's conclusions, and complain that only few employees of the Ministry are aware that SNL goals cannot be realised without CT (Landbouwschap, 1991:11). Similarly, they assess that extension organizations do not sufficiently recognize the importance of such technologies either (Landbouwschap, 1991:4). Thus, we see that the emphasis in the arguments staged to legitimize government investments in management automation tend to change over time, in accordance with general agricultural policy trends.

The conclusion must be that a strong belief in science and technology (and information technology in particular), together with arguments related to international competition, were important in legitimizing investments in agricultural CT. Given: (a) the vagueness of initial expectations; (b) the meagre results; and (c) despite the official emphasis on supporting and improving farmer decision making, I feel that the dominant idea underlying government investments in *management supporting* CT was that such CT were a precondition for bringing about Integrated Chain Management and -to a lesser extent- process automation (note that Blokker (1991) has in part reversed this argument later on[4]). It is mainly in relation to ICM that hard economic returns on investments can be made plausible. A more recent advantage attributed to ICM (and therefore to management automation) -on top of its potential to improve the competitive position of the sector as a whole- is that it can help to reduce environmental pollution and increase the effectiveness of environmental control.

Other and later sources than INSP-LV are slightly more specific in indicating the advantages of management supporting CT (e.g. Van Dijk, 1988; Wapenaar et al., 1989; Engel, 1989b; Ausher, 1991). Van Dijk (1988:xii-xiv) stresses that automation will be instrumental in applying knowledge that can help to reduce losses and spilling of scarce (and or polluting) resources. Furthermore, registration of data will provide information that leads to better control of production processes, amongst others by means of linking on-farm 'information-processing computers' with process automation. Also he argues that newly developed knowledge and societal goals can be incorporated in computer programs -e.g. simulation models- and provide more insight in management alternatives, as well as a better timing of interventions.

Ausher (1991:175) argues, from an extension point of view, that 'information technology' will allow for the formulation and efficient diffusion of "more precise and field-specific technical messages, based on an integration of relevant elements of some of the major production factors", in which he includes "human factors". Geuze (1991:139) makes a similar argument when he proposes that:

> "Knowledge is better and more completely transferred to practitioners through information systems. In this manner knowledge can be directly related to enterprise-specific circumstances, which allows for a refined steering of production processes" (transl. C.L.).

Wapenaar et al. (1989), as well as Engel (1989b), look at the promises of CT from a KIS perspective (see section 4.2). Wapenaar et al. (1989:216) identify the following advantages of CT:

- very fast availability of information;
- access to very large quantities of information;
- better targeting of information through interactive seeking-procedures;
- wide access to the newest and best knowledge available;
- fast interactive exchange of word, picture and sound over large distances between networks of users.

Engel (1989b:15) adds to this:

- the bridging of time and space constraints, amongst others by a-synchronic communication;
- the possibility to support consolidation of knowledge in a system, subsystem or network;
- the capacity to measure, regulate and/or control information and data-flows;
- the capacity to handle a high degree of diversity in knowledge and information.

Although most authors mentioned refer to problematic aspects of CT, Engel is the only one who makes these explicit, and identifies several weaknesses:

- IT applications find it very hard to interpret contextual information; as a consequence they find it difficult to validate sources of information and knowledge;
- IT applications, compared to humans, have very limited associative and interpretative powers;
- IT applications mostly go "nuts" when confronted with conflicting pieces of evidence not anticipated for, unless they are able to learn by asking input;
- IT applications do not socialize easily; they do not maintain social relationships;
- Reliability, protection and privacy of information stored in IT applications is a problem;
- Hardware and software incompatibilities create new barriers to information exchange, which are often very hard to bridge;
- Investment and maintenance costs of IT -in money, time and annoyance- are still inhibitive of its general use in agriculture. (cited from Engel, 1989b:15-16)

INSP-LV policies and organization

The main bottlenecks that were identified in the INSP-LV were: (1) insufficient availability of CT products and services; (2) a lack of coordination and integration in the sector as a whole, amongst others resulting in all sorts of incompatibilities; and (3) still the non-existence of a 'viable' market for CT-products and services (MLV, 1984:8). In order to remove bottlenecks and attain goals, a number of policies were issued, some of which will be discussed below.

Branch organizations and project subsidies for the market sector
A central element in the Ministry's policy was to financially support the emergence of so-called branch organizations. The central organizational structures that the Ministry had in mind initially, however, did not materialize, since existing organizations of horticulturists, pig farmers and dairy farmers took over the initiative, and erected their own branch organizations. Similarly, the original idea that these branch organizations could actually subsidize and be responsible for the development and exploitation of CT (MLV, 1984:9) was successfully curbed by agro-software firms, who found a willing ear in the Ministry for their argument that semi-state organizations should not take over functions that the market was

able to provide. Eventually, it was 'agreed' that the branch organizations were supposed to: (a) develop a vision on automation in agriculture; (b) be an independent, non-profit coordinating body; (c) create a systematic coherence of CT-products and services by bringing together initiatives from research and commercial sector, and (4) establish standards to ensure compatibility between different hardware and software packages[5].

In order to perform these tasks the branch organizations were to: (a) develop a policy plan; (b) create information models for each sector in close cooperation with research, commercial sector and extension (see section 7.4 for details); (c) initiate and stimulate demonstration projects; and (d) provide extension on the possibilities and advantages of automation.

In the end, five branch organizations were formed[6]. Moreover, these branch organizations, together with the three main farmers' unions, formed a coordinating body (COAL), which was to coordinate the activities of the branch organizations and take care of branch-exceeding affairs. Given the dominance of farmers' organizations in the branch organizations, it is not surprising that -apart from their objectives to encourage and coordinate CT development, and stimulate the use of CT to as wide an audience of farmers as possible- an additional aim of these organizations was to prevent farmers to be further manoeuvred into a 'dependent position' by agro-software firms. Even though actual effectiveness with regard to this latter aim can be disputed (see e.g. Frouws & Van der Ploeg, 1988), it is no wonder that the agro-software firms have in turn united themselves in 1986 into Agrarica Platform in order to coordinate their own activities, and defend their interests.

Both the branch organizations and their coordinating body (COAL) were designed to be important channels for the distribution of INSP-LV subsidies. The subsidies were made available by the Foundation Development and Sanitation Fund (O&S fonds) of the Ministry, which was advised by the National Council for Enterprise Development (LRB). In practice, however, project proposals needed to be nominated and approved by the branch organizations (Klink, 1991a:12; IBM, 1988:8); over 95 percent of the project subsidies granted were in fact joint proposals of the branch organizations and other institutions (personal comment by Ministry staff)[7].

At this stage, priority was given to the development of CT for on-farm use by the farmer, and in particular to the development of so-called '*integrated management systems*' or 'integral' management supporting systems (MSS) (see section 2.2). Later on the emphasis has shifted to demonstration projects and the development of partial systems (which -at a later stage- were to be included as modules in larger 'integrated' systems).

Research and extension policy

Another important policy was that research and development activities were to have a very *applied* nature, although they should not result in marketable CT-products; this last phase of development was to be left to the commercial sector. Therefore, the focus of research activities should be on the development of *experimental*, innovative CT applications, with the explicit aim to stimulate demand from primary agriculture. Only in some technical areas, fundamental research was allowed under the INSP-LV programme.

Although one gets the impression from the INSP-LV budget (Ministry of Economic Affairs, 1988) that research has been well endowed (92 million guilders), it has in fact been rather difficult to get specific research projects funded[8]. This was particularly so for social scientific projects. The apparent lack of money despite the seemingly large budget (41 million for the Agricultural University, and 51 million for agricultural research institutes), was caused mainly by the fact that both (already planned) investments in infrastructure (including hardware) and existing personnel capacity were included in the budget, so that little extra capacity was in fact created. In 1985, the ministerial project group Informatics Stimulation Plan Agricultural Research (INSP-LO) wrote a Plan of Action which included a number of projects, none of which were eventually provided with additional funds by the Ministry[9]. The funding of the next Plan of Action (1987) appeared difficult as well; in the end 5 million guilders became available over a five year period. It is of particular interest to note that none of the fourteen social scientific projects (resorting under three larger themes[10]) proposed in this latter plan were funded[11].

The results of a subsequent study by the National Council for Agricultural Research (NRLO, 1991) into the need for socio-economic research in relation to CT in the agricultural sector, have only resulted in actual research activities in 1993. This study called for research into four major themes: (a) goals and decision-making processes of farmers and horticulturists; (b) integration and deepening of management supporting systems; (c) system-interwovenness in the production column and government policy; and (d) consequences of information technology for labour, environment, income, farm size and employment.

In addition to research activities, INSP-LV announces active contributions from agricultural extension and education with regard to (re-)education of farmers and horticulturists. Although special funds were made available for agricultural education, agricultural extension suffered the same problems as agricultural research in the sense that relatively little additional funding was provided.

7.2 The present state of the art

Quantitative expectations and results

At the start of INSP-LV, in 1984, expectations with regard to the uptake of CT by farmers were still highly optimistic. No specific quantitative goals were formulated at the outset, but it was commonsense that a considerable percentage of farmers would be equipped with CT, especially 'integral' MSS, towards the end of the INSP-LV period. This optimistic attitude was -for example- reflected in the initial expectation that the branch organizations could become self-sustaining in the short term on the basis of income from royalties of the CT to which they had contributed (MLV, 1984:10).

Furthermore, the philosophy adopted was that, in order to reach greater efficiency at farm level, farmers needed MSS that could run on individual personal computers, rather than on central computers, as is the case with the French Minitel system (Netter, 1991). In line with this approach, electronic networks (such as videotex) for communication with external organizations, were to be preferably accessed through personal computers rather than through terminals.

In this context, the number of personal computers on farms (used for management purposes) became an important indicator for success of the INSP-LV programme. At present, different sources provide different estimates of this indicator. In table 7.1, I will present the estimates provided by the coordinating body COAL, by the evaluators of the INSP-LV and post-INSP-LV period, and by the Netherlands Central Bureau of Statistics (CBS). It must be noted that the MSS included in the table are by no means restricted to the integral MSS which were aimed at during the INSP-LV period. In fact, such systems have never fully materialized. Therefore, on-farm systems that are only used for registration and/or bookkeeping are included as well.

Table 7.1: The number of personal computers used in combination with MSS, per year, per branch, and by different sources. The number of commercially available 'integral' MSS per branch is indicated between brackets [..].

	COAL					INSP-LV evaluators		CBS *
	1986	1987	1988	1989	1990	total nr. of farms in 1990	1990	1990
dairy/beef [7]	60	150	400	800	1,100	49,000	800	2,100
pigs [10]	160	400	700	1,400	2,500	35,000	1,600	comb
poultry [?]	20	75	150	250	270	6,400 ****	250	1,400
arable farm. [8]	60	185	260	600	900	17,000	750	1,300
horticulture [?]	100	400	1,000	1,250	1,500	16,000 **	2,225 ***	2,100
TOTAL	400	1,210	2,510	4,300	6,270	123,400	5,625	6,900

* CBS figures (based on the yearly census on all farms) are labelled 'provisional' in LEI/CBS (1991:47)
** This figure relates to glasshouse horticulturists only.
*** Alkemade (1991) gives no exact figure in this respect. According to him, 1400 glasshouse vegetable growers use an automated system for farm comparisons. Also, 1,000 horticulturists have a registration system, 350 of which are vegetable growers. If we assume that half of those with a registration system are also involved in automated farm comparisons, we arrive at an estimated 2,225 PC's used in combination with a management system.
**** For poultry farming there is not a unambiguous 'commonly' used number of farms; since poultry farms tend to be specialized, I have calculated the number of poultry farms on the basis of mainly LEI/CBS figures. According to LEI/CBS (1991), there are 5,867 farms with one or more chicken units and 86 duck farms, furthermore (according to Hilhorst & De Visser, 1991b) there are 290 farms with furred animals, 134 turkey farms, and 70 farms with rabbits.

Sources: COAL estimates: Geuze, 1991. INSP-LV estimates and available 'integral' MSS: Klink, 1991a, 1990a, 1990b; Alkemade, 1991; De Visser & Hilhorst, 1990; SIVA, 1988. CBS estimates: LEI/CBS, 1991.

If we assume that the figures provided by the INSP-LV evaluators are the most reliable, it emerges that on average about 4.6 percent of the farmers uses a MSS on a personal computer (see table 7.2). In order to present a more positive view, it is common usage to 'correct' the number of farms by arguing that many farms within the branch are too small to use MSS, and/or will 'autonomously' (Visser & Hilhorst, 1990:7) disappear in the next decade. In this manner, the INSP-LV evaluators -using the term 'potential target-group'- manage to arrive at an average of 9.5 percent by making more than half of the farmers and growers 'invisible'. Such ways of reasoning clearly reflect the common (and possibly self-fulfilling) contention among agro-informaticians that CT for management purposes can be efficiently used mainly on larger enterprises; i.e. that there is an inherent connection between scale enlargement and management automation.

Table 7.2: Different calculations concerning the percentage of personal computers used in combination with MSS for each branch in 1990.

INSP-LV evaluators' estimates		% of commonly used total number of farms	% of INSP-LV evaluators' 'potential target-group'	% of LEI/CBS total number of branch-units
dairy/ beef:	800	1.6 % of 49,000	3.5 % of 23,000	1.1 % of 70,500 (47,000 + 23,500)
pigs:	1,600	4.6 % of 35,000	10.3 % of 15,500	4.2 % of 37,700 (13,400 + 24,300)
poultry:	250	3.9 % of 6,400	8.1 % of 3,100	3.9 % of 6,400
arable farming:	750	4.4 % of 17,000	7.0 % of 10,700	2.1 % of 35,400 **
horti-culture:	2,225	13.9 % of 16,000 *	32.0 % of 7,000 *	5.6 % of 40,000 ** (25,600 + 14,400)
TOTAL	5,625	4.6 % of 123,400	9.5 % of 59,300	3.0 % of 190,000

* These figures relate to glasshouse horticulturists only.
** Both for horticulture and for arable farming the number of units could be even higher if I would differentiate between the different crops that are grown on one enterprise. Such a calculation makes sense to the extent that different crops might altogether need completely different MSS (which in horticulture at least is certainly the case; see chapter 9).

Sources: INSP-LV number of farms: Klink, 1990a, 1990b; Alkemade, 1991; SIVA, 1988; De Visser & Hilhorst, 1990. INSP-LV 'potential target-groups': Klink, 1991a, 1990a, 1990b; Alkemade, 1991; De Visser & Hilhorst, 1990. CBS branch-units: LEI/CBS, 1991; Klink, 1990b; Misset, 1989; Hilhorst & De Visser, 1991b).

However, there are good reasons to paint an even less flattering picture than the commonly presented 'uncorrected' figures, since these figures seem to be inconsistently calculated. This inconsistency is related to the fact that many farms are not completely specialized, but have -according to the common branch classification- activities in several branches, so that a farm can be conceptually split up into different branch-units. Most of the INSP-LV evaluators' figures (except those concerning pig farmers) are based on LEI/CBS and EC criteria for designating a farm as 'a dairy farm', 'a poultry farm', 'an arable farm', etc. This criterion is that 2/3 of the BSS (gross standard balances, expressed in ECU) originate from this particular branch-unit. This means, for example, that there may be a considerable number of mixed farms with significant activities in arable farming, that are nevertheless designated as 'a dairy farm' or 'a pig farm'.

Using the LEI/CBS classification, for example, there were only 9,216 'pig farms' in 1990 (LEI/CBS, 1991:27), whereas there were 13,391 enterprises which had sows, and 24,281 farms with porkers (total 37,672 branch-units spread over 28,989 farms, since 8,683 farms have both sows and porkers). Given the fact that most of the CT (and especially 'integral' MSS) developed under INSP-LV are geared towards specialized (sub-)branches, it seems quite legitimate that -in the case of pig farming- authors (e.g. Annevelink & Huisman, 1991) commonly use the total number of branch-units in their calculations concerning CT-use by pig farmers. For most other branches, however, this calculation method is rarely followed.

For arable farming, for example, agro-informaticians often calculate with the figure of 17,000 specialized farms (e.g. De Visser & Hilhorst, 1990; Annevelink & Huisman, 1991), whereas according to LEI/CBS statistics there are 63,576 enterprises with arable farming units (LEI/CBS, 1991:66). Even if one corrects this number for cattle farmers that grow maize as fodder, one arrives at about 35,400 enterprises (Misset, 1989) in 1990; 20,124 of these were growing cereals, while 30,152 farms had tuberous plants and/or root-crops, etc. (LEI/CBS, 1991:64).

Another bias in INSP-LV figures is that some major sub-branches are not considered (e.g. beef-cattle farming with 23,500 enterprises (Klink, 1990b:5), and horticulture in the open air with 25,624 enterprises). This is apparently so since few CT are available for these farmers and growers, even if their sub-branches are without doubt specific enough to justify the development of specialized CT. In the fourth column of table 7.2 I have provisionally calculated percentages on the basis of branch-unit estimates derived mainly from LEI/CBS (1991).

Of course, I am aware that the number of personal computers used in combination with MSS is a rather arbitrary figure. It is especially meaningful in relation to the philosophy adopted in INSP-LV, but certainly not the only figure of importance. It appears, for example, that quite a number of farmers and growers make use of MSS that run on a central computer to which they have no access. That is, they get written and/or oral reproductions on the basis of CT that are operated by others (e.g. accountants, salesmen, extension workers, etc.). Others have subscribed to a videotex network through which they can communicate with their institutional environment and/or other farmers and growers, or even make use of centrally run management systems.

The MSS and videotex services which are included in table 7.3, have all been designed to be used on a more or less regular basis by farmers (with or without mediation by extension workers, salesmen, accountants, etc.), and are provided by public and/or commercial extension services, accountancy bureaus, veterinarians, herd-book organizations, input suppliers, banks, etc.

Table 7.3: Number of farmers/growers for each branch that in one way or another used centrally operated MSS, and/or subscribed to a videotex system, in 1990.

	Estimated number of users of centrally operated MSS (1990)		Estimated number of videotex users (1990)
dairy/beef	'integral' MSS: breeding module: coupling milk inspection/feeding: farm accounts based MSS:	2,000 7,000 7,300 4,100	300
pigs	'integral' MSS: farm-account based MSS:	4,000 2,500	60
poultry	'technical economic adminstration'	3,500 *	nil
arable farming	nihil		1,100
horticulture	nihil		4,200

* The figure of 3,500 is rather speculative. Klink (1991a:6) argues that "almost all" poultry farmers participate in some form of 'technical economic administration', while Hilhorst & De Visser (1991b:6) use the term "a great majority". It is not immediately clear whether these descriptions refer to what they call the 'potential target-group' (n=3,100) or to the total amount of poultry farmers (n=6,400). In a personal comment, one of the authors explained that these descriptions originate from the feed industries who are the main operators of 'technical economic administrations', but who are reluctant to give detailed information. Several other sources within the poultry branch (such as the Netherlands Organization of Poultry farmers and the IKC for poultry farming) are unable to give more reliable information either.

Sources: Klink, 1991a, 1990a, 1990b; Alkemade, 1991; De Visser & Hilhorst, 1990; Hilhorst & De Visser, 1991b; Hofman & Van Laar, 1990.

Other CT are designed to be of help in situations that individual farmers and/or growers do only rarely meet (e.g. building new farm buildings, analyzing particular problems, etc.). Such CT, then, may thus be regularly used by extension workers and the like, but not by farmers. In 1987, an inventory was made within the public extension service of different (existing and required) so called 'Extension Supporting Systems' (VOS-WELKE, 1987; Van Gils, 1988). The results of this inventory in terms of the number of available and required CT (either to be used on a regular basis by farmers, extension workers, or both) are summarized in the tables 7.4 and 7.5.

Although in INSP-LV there was relatively little attention for process automation (the experience and/or assumption was that these technologies would spread 'autonomously', and thus needed little additional stimulation), it is relevant to give an indication of the types and numbers of process automation packages used in the different branches (see table 7.7).

Table 7.4: Existing and required ESS in 1988

Branch	Required ESS	Existing ESS
dairy	57	35
beef-cattle	4	1
goats and sheep	6	1
horses	5	0
pigs	19	12
poultry	23	13
horticulture under glass	25	21
fruit	4	3
arable farming and non-glasshouse horticulture	40	15
nurseries (trees)	14	3
bulbs	13	3
mushrooms	6	4
bees	2	0
soil/water/fertilization/environment	19	3
crop-protection	7	2
quality and storage	3	2
labour and farm equipment (stables/mechanization)	7	8
TOTAL	258	131

Source: VOS-WELKE, 1987; Van Gils, 1988.

Table 7.5: The nature of ESS in the 1988 inventory

economic (economic advise, registration, budgeting, etc.)	50 %
farm equipment (technical calculations on stables/mechanization)	16 %
soil/water/fertilization	10 %
production planning (crop-rotation, reproduction)	8 %
feed and fodder provision	8 %
other (crop-protection, hygiene, quality pollination)	8 %

Sources: VOS-WELKE, 1987; Van Gils, 1988.

Table 7.7: Numbers and types of process automation packages used per branch in 1990.

dairy/beef	automated concentrate feeding: automated milk measuring: automated climate control (stables)	8,000 * 500 350
pigs and poultry	automated concentrate feeding: automated climate control (stables):	650 3,500
arable farming	automated climate control (storage): tractor and implement control:	2,000 unknown
horticulture	automated climate control (glasshouse): automated substrate feeding control:	7,000 ** 2,600

* LEI/CBS estimates 6,700, while Klink (1990b) arrives at 9,000.
** LEI/CBS estimates 7,000, while Alkemade (1990) arrives at 6,500.
Sources: LEI/CBS (1991); Alkemade, 1991; De Visser & Hilhorst, 1990; Klink, 1990b.

The common evaluation of quantitative results: a flavour of 'user-blame'

The overall conclusion that is drawn in (post)-INSP-LV evaluation reports, is that -contrary to process automation- there are only few applications in the field of management automation and automated communication that enjoy an 'autonomous growth' of the number of users. Although it is argued that this state of affairs is in part caused by problems on the 'supply side' (i.e. compatibility and standardization problems, institutional problems, problems in CT performance and functionality), it is emphasized that there are bottlenecks on the 'demand side' as well:

> "In most branches the number of users of information systems is still limited. The causes for this are not so much to be found on the supply side, but rather on the demand side" (Klink, 1991:9; transl. CL)

The tenor of the various evaluation reports (the contents of which were thoroughly discussed with CT developers and scientists of various origins; Klink, 1991, 1990a, 1990b; Hilhorst & De Visser, 1990; Alkemade, 1991) seems to be that -despite 'supply side' problems- the number, range and quality of available CT products are quite adequate.

Box 7.1: **A relatively adequate supply of CT, but for whose demands?**
In the final version of his evaluation report Klink (1991:i) states that: "The available information systems reasonably satisfy present wants. The pace of further extensions and new developments is predominantly determined by the emergence and availability of formalized agricultural knowledge." In a draft version of the same report Klink (1990c:9) puts it more boldly (and therefore presumably more politically sensitive and susceptible to criticism), when he argues that: "The present systems cater for all functions for which automation makes sense. Despite the bad market, suppliers do reasonably meet the demand." (transl. CL) Note that apparently -since the market is 'bad'- Klink refers here to the demands of non-farmers, most likely those of policy makers and branch organization officials.

The 'demand side' problems, then, are described as follows:

> "There are also situations in which the (surplus) value of an enterprise-management system is -in the context of present working methods- limited. This is particularly the case when:
> - the number of units that is distinguished on the enterprise is limited, so that one has sufficient overview even without an automated information system;
> - the agrarian entrepreneur does not -or only to a limited extent- analyze the available information from process-regulation or external information systems, and thus has no need for additional information" (Klink, 1991:i; transl. CL).

From other phrases, it becomes clear not only that especially the latter of the two conditions described above is deemed undesirable by the evaluators, but also that they associate such cases with a specific category (and therefore classification) of farmers:

> "In certain situations the farmers' needs for parameters, etc. are satisfied in a different manner, so that a management system has a surplus value only when the agrarian entrepreneur feels a need to profoundly analyze the available information. It can be ascertained that with 'frontrunners' who are accustomed to experiment themselves, this need is always present. 'Followers' who do not

experiment, need a discussion partner in order to further analyze parameters and comparable information, and draw conclusions that influence farming practice. Such a discussion partner might be a private or state extension worker, a field-staff member, a veterinarian or a colleague in a study club. The availability of such a form of regular supervision in the interpretation of available information, strongly determines the usefulness of the information, and thus the usefulness of the information system. Insufficient availability of supervision can therefore be another cause for the limited demand for management systems" (Klink, 1991a:10; transl. CL).

The apparent assumptions regarding: (a) the (limited) interpretative and analytical capacities of large numbers of farmers; (b) the validity and applicability of the 'frontrunner', 'follower' and 'straggler' (or 'laggard') classification; (c) their respective characteristics as far as experimentation is concerned; (d) the (profound) analytical potential offered by MSS; and (e) the idea that it is 'they' (the farmers) that have to learn something rather than 'us' (the developers and promoters of CT), are even more explicitly expressed in a statement which specifically relates to dairy farmers. Note that the following statement also seems to assume that information has an unambiguous meaning, that needs to be 'uncovered' by farmers.

"If, however, the dairy farmer himself has not -or only to a limited extent- learned to observe and register, then it is most doubtful whether he can actually analyze the information offered. The one, namely, is closely related to the other. As long as the dairy farmer only absorbs information, and does not further analyze it, he has no need for an integrated management system on his own PC. This is especially so since the value of such a management system must be found in the potential to not only be provided with a standard way of representing the available data, but also with the opportunity to order them from different points of view.

The fact that the demand for the additional information products of the cattle-improvement organizations is (still?) limited as well, could also be an indication that the dairy farmer does not know very well what he should do with the information.

In contrast to the use of machinery, one cannot -in the case of information systems- suffice by learning a new farming practice once only. It is only if one wants to continuously get something new out of the available information, that an information system becomes valuable.

In case of frontrunners this bottleneck does not occur. They have an attitude in which they are continuously experimenting and looking for new information. Followers do not have that attitude. Also it will be impossible to teach such an attitude by means of simple instruction.

If this is really the fundamental cause of the slow growth in the number of users of management systems, then the number of users will in the future too be limited to those enterprises where the manager has learned to analyze.

Among sow farmers too it has been ascertained that a large number of users of management systems use them almost exclusively for the attention-lists and the sow-charts; they do not -or only to a limited extent- use the available parameters" (Klink, 1990b:28; transl. CL).

The main solutions presented by agro-informaticians in order to solve and alleviate the problems in relation to the limited adoption of MSS are:

(1) providing extension and supervision in relation to CT;
(2) more standardization, uniformity, cooperation and coordination;
(3) the development of new formalized and structured knowledge;
(4) more research on information needs;
(5) an improvement of the 'user-friendliness' of software packages.

(See for sources and details chapter 2.)

Branch-specific characteristics and interpretations

In order to be able to relate the above general qualitative conclusions with the figures given in tables 7.1 to 7.7, and in order to understand the numeric differences and discrepancies between the branches, it may be useful briefly to elaborate on some relevant characteristics of the different branches.

The dairy branch
The relatively limited uptake of personal computers in combination with 'integral' MSS in the dairy branch is one of the major disappointments of INSP-LV (see e.g. Klink, 1991a, 1991b, 1990b). Apart from explaining this situation by calling upon the 'supply side' and 'demand side' problems mentioned above, it is recognized that there are some practical, historical and institutional particularities that may be of relevance (see e.g. Klink, 1990b, 1991b).

First, there is a more than a century long history of institutional collection and comparison of milk production and other data concerning individual cows. At present, the national herd-book organization (NRS) and the Society for Animal Health-care (SGD) administer huge databases in which all cattle in the Netherlands are registered by (amongst others) name, descent, posterity, exterior characteristics, medical history, displacement history, etc. Furthermore, the monthly milk inspection data (collected from all cows of more than 30,000 presently participating dairy farmers) are stored as well. Thus, dairy farmers have a long history of getting external feedback on individual cows. In fact, the two most widely used centrally operated MSS in the dairy branch (the breeding module (Steer Advisory Program, SAP) and the feed advisory package (Coupling Milk Inspection Cattle Feeding, KMV, see table 7.3) are based on NRS and SGD databases, and are provided at relatively low cost[12]. Clearly, these centrally operated packages partly overlap -and therefore compete- with 'integral' MSS. Moreover, process-automation packages (predominantly automated concentrate feeders, see table 7.6) -apart from registering actual feed use from individual cows- often provide facilities similar to those in 'integral' MSS as well (e.g. cow calendars, attention lists, etc.).

It could be argued that, because of these and other existing information infrastructures (e.g. 'partial' information services provided by dairy industries, veterinarians, accountants, feed suppliers, media, manual cow calendars, etc.) dairy farmers have little need for 'integral' MSS. Another way of interpreting this situation, as Klink (1990b:27-28) seems to do, is that dairy farmers have somehow lost the capacity and/or motivation to observe and register themselves, since important registration functions have been 'externalized' (i.e. are performed by others and/or process computers). This, according to Klink, results in the 'demand side' problems mentioned earlier.

A second point that may be of relevance, is that -in contrast to for example the pig branch- 'integral' MSS tend to be sold as separate products (Klink, 1990b:27, 1991b:12). In the pig branch, animal-feed industries -which provide close to a 100 percent of the feed and fodder needed, and with whom pig farmers often have a close relationship- play a prominent role in the development and promotion of such systems. Many feed industries have made MSS an inherent part of a larger package of input supply, and regular extension activities. In the dairy branch, however, the seven 'integral' MSS that are on the market, are predominantly developed, distributed and supported by specialized software firms and/or machinery suppliers, who have little other relationship with the dairy farmers than the actual provision of machinery and automation products. Similarly, the relationships between dairy farmers (for whom feed compounds are only an addition to grass, silage and maize) and feed industries (who have developed two out of the seven management systems) are not as strong as in the pig branch. Extension and supervision activities by feed industries around 'integral' MSS, therefore, are less prominent in the dairy branch. In this context, it is not too surprising that the bulk of 'integral' MSS that are used in the dairy branch are linked with veterinarians (with whom farmers usually have a frequent and long-standing contact). By far the most widely used (and mostly centrally operated) 'integral' MSS (see table 7.3) has been developed by the Faculty of Veterinary Science, and is usually administered and operated by local veterinarians[13]. Similarly, a relatively large number of dairy farmers (4,100; see table 7.3) participate in centrally operated MSS which are administered jointly by accountancy bureaus, and state-subsidized research and extension institutions.

The pig branch

In terms of the quantitative use of 'integral' MSS on personal computers, the pig branch is considered to be the most successful. Although the horticulture beats the pig branch in terms of the percentage of personal computers used in combination with MSS (see table 7.2), the types of MSS developed in the pig branch approximate the ideal of 'integral' MSS much closer than those in horticulture. As mentioned in the previous section (see also Klink, 1991a, 1990a, 1991c), this relative success is commonly attributed to the fact that feed industries sell, promote and/or support 'integral' MSS (either developed by themselves or other organizations) as an element in their strategy to tie customers. Several feed industries have engaged in providing extensive extension activities long before the introduction of MSS, but the supervision and support of MSS has now become an integral element therein. Moreover, the costs of developing and supporting such MSS, have often not been fully (at least not directly) charged to pig farmers, but are earned back through the sale of goods.

Other common explanations in this respect, refer to the fact that pig farmers usually deal with a larger number of units than dairy farmers, so that they have a greater need for formalized information storage and retrieval; i.e. the possibility to administer things mentally is limited. This, then, is supposedly related to the fact that, for example, many sow-breeders were already used to manually register data on so-called 'sow charts'. In many ways it can be argued that most 'integral' MSS for sow breeders are, in fact, automated sow charts which have been 'extended' with extra facilities, possibilities for representation, etc. Furthermore, the relevance of information provided by MSS in the pig branch may be comparatively high, since there seem to be fewer and more controllable factors influencing the eventual technical results than in -for example- dairy farming. Finally, it is claimed that research has pointed out that there is a positive causal relation between the use of MSS and number of piglets per sow per year. Thus, it is argued that -in contrast to many other branches[14]- it has been proven that pig farmers can actually earn money by using an 'integral' MSS. An attempt to trace back this claim has led to an internal study by a large feed industry (De Jager, 1988). Although Verstegen et al. (1993) criticize the design of De Jager's study, they essentially arrive at a similar conclusion. Whatever the validity of these claims[15], they have indeed become important elements in the discourse surrounding management automation in pig farming which may indeed have had consequences in terms of the actual use of MSS.

Arable farming

Like the dairy branch, arable farming is considered a 'problem branch' in relation to management automation. In addition to 'supply side' and 'demand side' problems referred to earlier, a number of additional assumptions are often used to explain this situation. De Visser & Hilhorst (1990:2, 8-10), for example, argue that arable farms tend to be relatively 'data poor': (a) they tend to have a relatively long production cycle, which means that much information is needed only once a year, rather than on a regular or routine-like basis; (b) the number of production units (De Visser & Hilhorst (1990:9) speak of 'crops' while Klink (1991a:6) speaks of 'production plots') is relatively limited, so that registration and calculation of parameters becomes less sensible; and (c) crucial production conditions such as the weather can hardly be controlled, so that no information is needed to manipulate them. Hilhorst & De Visser conclude that -given the severe economic problems in arable farming- the return on investment in management automation is difficult to demonstrate. This coincides with their observation that many arable farmers still see investments in CT primarily as a 'private' and not as a 'business' investment, even if they are convinced that - in the long term- automation is 'the proper way to go' for the farming enterprise as well (1991a:11).

Partly in contradiction with their claim that arable farming is 'data poor', De Visser & Hilhorst (1990:8,10) also assert that arable farmers operate in a rather diverse institutional environment (they are usually involved in a variety of production chains), so that information exchange is of "eminent" importance. At the same time, however, they contend that the magnitude and frequency of such information exchanges is limited (Hilhorst & De Visser, 1991a:17), which apparently makes automated communication less feasible.

Despite the present drawbacks, however, it is argued (Klink, 1991a:7; Hilhorst & De Visser, 1991a:14) that in arable farming too, CT can play an important role in realizing ministerial (SNL) goals (see section 7.1).

An interesting phenomenon within arable farming is that three of the eight available 'integral' MSS were (at least originally) developed and maintained by individual arable farmers for their own purposes (see De Visser & Hilhorst, 1990:12); to my knowledge there are no examples of commercially marketed 'integral' MSS that were originally developed by farmers in other branches. Clearly, this observation raises some questions with regard to the supposedly limited usefulness of such systems in arable farming, unless one assumes that these arable farmers have merely invested so much time for commercial reasons, or in order to 'kill the time' in winter.

Glasshouse horticulture

The major sub-branches within glasshouse horticulture are vegetable production, flower production and the production of potted plants. As a whole the branch is by far the most 'automated', both with regard to 'management automation', 'process automation' and 'automated communication'. Nevertheless, and perhaps surprisingly, the branch is not usually regarded as the most successful branch in terms of CT use, primarily because the characteristics of the MSS that are developed do not seem to match the philosophies adopted by INSP-LV.

Since 1975, automation in the branch has taken off with the introduction of computers for automated climate control. By now, about 44 percent of glasshouse horticulturists have a comprehensive climate computer, which means that a fairly large number of growers have both experience with computers and access to computer hardware. Moreover, this development has resulted in elaborate organizational infrastructures for maintenance and support of computer hardware and software, which predates INSP-LV. The dominant forms of management automation applied in the branch are registration systems and enterprise comparison systems (see table 7.1). Organizations of horticulturists, suppliers of climate computers and auctions have been active in developing and initiating such systems which are mainly geared towards the registration, retrieval, manipulation and exchange (among groups of growers) of the substantial amounts of data that can be derived from climate computers and auctions. As I said earlier, these CT are not considered proper 'integral' MSS in the INSP-LV sense. More specifically, the INSP-LV evaluators assess that glasshouse horticulture lacks MSS that support the day-to-day management of the enterprise (Alkemade, 1991:9), which he attributes mainly to the enormous complexity of (and lack of knowledge about) the interrelations between different climatological parameters, crop-protection, fertilization, etc. Klink (1991a:7) adds that proper MSS in glasshouse horticulture will need to be crop-specific, which -given the variety of horticultural crops and the small number of growers per crop- implies that the costs for developing such systems are a major obstacle.

A striking feature of glasshouse horticulture is the relatively widespread use of videotex systems (see table 7.3), which has emerged largely without INSP-LV involvement. The majority of videotex connections is almost exclusively used by growers for the retrieval of the daily auction accounts. These videotex systems are a service offered by auctions which allows them to economize on paper and postage costs, while growers get a real-time feedback on sale prices.

The poultry branch

The poultry branch is small, and includes farms with a number of different specializations, such as layers, broilers, chick production, furred animals, ducks, turkeys, rabbits, etc. As in the horticultural branch, the relatively small number of farmers per sub-branch is an impediment to the development of INSP-LV-style 'integral' MSS that are suitable for use on a daily basis. According to Hilhorst & De Visser (1991b:11), other hindrances are that present-day poultry production systems -like in arable farming- usually involve a limited number of production units (groups of animals instead of individual animals), with few control possibilities for individual animals.

In other respects, the poultry branch resembles the pig branch. The relations between poultry farmers and other elements in the chain (and particularly feed-industries) are strongly developed. In the poultry branch too, the feed industries have made MSS an integral part of their services to farmers. Most of these are centrally operated, and are referred to as 'technical economic administrations' (TEA; see table 7.3). Such TEA basically calculate parameters on the basis of mainly technical data and farm accounts. The development of such systems was initiated by the public extension service, but now there are several (incompatible) TEA available, which are operated by extension services, veterinarians and/or feed industries (Hilhorst & De Visser, 1991b:10,12).

Despite the present problems in relation to 'integral' MSS, it is expected that such systems will in the future play an important role in bridging the gap[16] between process automation and TEA's (Hilhorst & De Visser, 1991b:17). Moreover, such systems have a role to play in the realization of SNL goals (Hilhorst & De Visser, 1991b:14-15).

The involvement of the (semi)state extension service

Klink's (1991d:8) argument that both the involvement of extension workers in CT-development processes and extension and supervision activities around CT are 'critical success factors' for improving the quality and quantity of CT-use by farmers, apparently implies that there has been too little of this in the recent past. According to Klink (1991d:11), the (semi)state extension service (DLV) and Information and Knowledge Centres (IKC): "could take more initiative in directing the expansion of existing information systems; especially those which are used at farm level on the on-farm computer. Other extension workers [i.e. extension workers of commercial services, CL] already do so."

The reluctance of extension staff to engage in INSP-LV-related projects had certain grounds. First, as I have shown earlier, little additional funding was made available, so that extension endeavours in relation to CT had to take place on top of existing activities. Second, before the partial privatization of the service from 1990 onwards, the Ministry had hindered several CT-projects initiated by the extension service itself, with the argument that the public extension service was not the appropriate institution to develop and market such technologies (see for an example section 8.1). Third, extension staff felt that they were confronted with several CT (developed primarily by research institutes), which were more or less imposed on them, and/or of little practical use. Fourth, in the field, extension workers were confronted with a variety of commercially developed 'integral' MSS that: (a) they had not learned to work with; (b) included databases that they could not access; (c) incorporated models in which they had only limited insight; (d) were not developed with their participation; and (e) left supervision gaps that in principle they could fill up; however, no rewards were available for doing so. Fifth, one should not forget that until recently it was quite common to think that CT would in fact replace extension workers, or at least alter the nature of their work considerably.

Box 7.2: **From being redundant to being a saviour**

The designation of extension as a 'critical success factor' for CT-use implies a *reversal* of the expectations and philosophy that went along with the introduction of CT. In the early days of INSP-LV, it was not uncommon to think that -as a result of the potential of CT with regard to fine-tuning, etc.- the extension worker would virtually disappear from the scene. An IBM brochure puts it this way: "It is to be expected that extension activities for farmers too will be automated to a large extent. The situation whereby extension workers were easily available to be called out on request for a personal on-farm visit, will not -or hardly- exist any more." (IBM, 1988:4) (Transl. CL). To put it somewhat provocatively: we have now arrived at the paradoxical situation that extension workers are called in to ensure the survival of CT that were originally meant to replace them.

Last but not least, in recent years the extension service has gone through a major -and sometimes painful- process of reorganization and privatization, which has taken a lot of time and energy. In all, a certain amount of reservation on the side of extension staff was not too surprising.

Despite the somewhat tense episodes in the relationship between the (semi)state extension service and INSP-LV and/or commercial CT-development activities, it would be incorrect to claim that extension staff have been passive in relation to CT. As I have mentioned earlier, extension workers were among the first to develop CT in various degrees of complexity, i.e. so called 'Extension Supporting Systems' (ESS). At present, the privatized DLV aims at developing a comprehensive ESS in which a number of presently independent ESS are integrated. This system is to be provided with interfaces which allows data-exchange with other MSS, so that existing databases can be used to help generate analyses and advice[17].

Similarly, DLV has recently signed contracts with commercial agro-software firms for DLV supervision and support of farmers that use CT developed by the latter (Snel, 1992:13). Moreover, DLV has participated in (and in some cases even initiated) several videotex systems by providing information services through these electronic networks. Finally, from its start in 1990 onwards, DLV has given advice to farmers on both the possibilities of automation in general, and the qualities and characteristics of specific CT (Snel, 1992:12).

7.3 Towards a classification of computer-based communication technologies

Problematizing current classifications and dimensions

In the agro-informatics literature and discourse it is easy to get lost in a jungle of terminologies that are used to refer to specific types of CT. Frequently used terms in this respect are for example: management supporting systems, decision support systems, crop supervision systems, evaluation systems, management information systems, integral management systems, extension supporting systems, expert systems, knowledge systems, knowledge-based systems, videotex systems, databases, information delivery systems, systems for electronic data interchange, advisory systems, technical economic administrations, educational systems, multimedia, interactive multimedia, etc. This multitude of terms is rather confusing, especially since it is often not clear on the basis of which dimensions they can be distinguished from each other. In practice, for example, the terms 'knowledge system' and 'videotex system' refer to packages which exhibit certain software and/or hardware characteristics, while the terms 'extension supporting system' and 'educational system' are clearly associated with certain organizational contexts. Other terms - such as 'expert system', 'multimedia' or 'information delivery system'- seem to have functional connotations. Moreover, there are a number of 'logical' complications; the terms 'decision support system' and 'database', for example, seem -at least for an informed layman- to have little distinctive power since virtually all systems aim at providing 'decision support', while most of them make use of database techniques.

In the scientific literature it is hard to find a generally accepted classification of CT/IT, and it is even harder to fit present-day agricultural CT in such a classification.

Several authors in computer science distinguish between different historical stages of computer application in organizations. In this historical sense, for example, Sol (1984) speaks of automated data processing (ADP), management information systems (MIS) and decision support systems (DSS). Van den Herik (1988) (building on Sol) has later added so-called expert systems (ES). Table 7.8 gives a summary of the different characteristics which Sol and van den Herik associate with their classification.

Table 7.8: Historical phases of the application of computers in organizations, combining similar tables by Sol (1984:11) and Van den Herik (1988:19).

PHASE	ADP	MIS	DSS	ES
hardware characteristics	central computer batch processing	central on-line processing	decentralized, personal computing	
type of problems	(well) structured processes	(well) defined information provision	ill-structured decision support	independent reasoning
mode of thinking	process-oriented	data-oriented	object-oriented	relation-oriented
mode of modelling	deductive	inductive	hypothetic-inductive	heuristic-recursive
needs to be satisfied	direct information needs	identification of connections	indirect information needs	identification of indirect connections
working method	linear	iterative	incremental	heuristic-incremental
project management	project team	harmony	participatory	participatory, partly replacing

While both Sol and Van den Herik seem to treat DSS as an independent category of systems, Davis & Olson (1985) speak of DSS as a sub-class of MIS. MIS are defined as:

> "an integrated, user-machine system for providing information to support operations, management, and decision-making functions in an organization. The system utilizes computer hardware and software; manual procedures; models for analysis, planning, control and decision making; and a database" (Davis & Olson, 1985:6).

With reference to Alter (1980), Davis & Olson (1985:368) emphasize that DSS *support* rather than *automate* decision making, and -following Keen (1976)- identify the following assumptions which underlie DSS:

1. The computer must *support* the manager but not replace his or her judgement. It should therefore neither try to provide the "answers" nor impose a predefined sequence of analysis.
2. The main pay-off of computer support is for *semistructured* problems, where parts of the analysis can be systematized for the computer, but where the decision maker's insight an judgement are needed to control the process.
3. Effective problem solving is *interactive* and is enhanced by a dialog between the user and the system. The user explores the problem situation using the analytic and information-providing capabilities of the system as well as human experience and insights (cited from Davis & Olson, 1985:368-369).

Box 7.3: **DSS in practice, and the use of the label as an excuse**
Although these assumptions underlying the concept of DSS seem quite sensible, it is my experience that 'agricultural' CT which are labelled 'DSS' have characteristics which contradict the

assumptions referred to by Davis & Olson. Many DSS tend to have rather rigid and normative implications, and leave little room for the decision maker's insight and judgement. Frequently, DSS seem to frustrate rather than support the decision maker; that is, farmers often ignore, and indicate their disappointment with, specific advice offered by CT. CT-developers sometimes deal with these frustrations in an interesting manner. If they do not resort to blaming the user, they argue that it is in the very nature of DSS that users do not do what the DSS advises them to do, since DSS are there to 'support' rather than to 'replace' the decision maker anyway. In these cases, the term 'DSS' has become an *excuse* for delivering bad advice.

As my case-studies will show, it is -in practice- rather difficult to generate DSS which take account of the assumptions listed by Davis & Olson. In this book I hope to both demonstrate *why* this is so difficult, and *how* we might attempt to deal with this.

In contrast to Davis & Olson, some authors conceptualize DSS, rather than MIS, as the overall category of systems. Clarke & Finlay (1989), for example, distinguish two major types of DSS: management information systems (MIS) and management intelligence systems (MINTS). The essential concern of MIS (which can be subdivided into data retrieval systems and extrapolatory systems) is efficiency (doing the thing right), while the primary concern of MINTS (subdivided into option selection systems and scenario development systems) is effectiveness (doing the right thing) (1989:90). Both Clarke & Finlay (1989:91) and Finlay & Forghani (1987:48) associate MINTS with: (a) insight, learning, dialogue; (b) intelligence; (c) planning; (d) context dependency; (e) a given scenario; and (f) ad hoc/contingent objectives; and MIS with: (a) providing answers; (b) information; (c) internal control/budgeting; (d) context independency; (e) fixed policies; and (f) pre-specified objectives. Given their characteristics, Finlay & Forghani (1987:48-49) suggest that MINTS might fit well into Checkland's (1981) Soft Systems Methodology.

Most classifications of CT (including those mentioned above) are associated with the distinction between 'structured', 'semi-structured' and 'ill-structured' problems or decisions (and/or a discrimination between various levels of 'uncertainty')[18]. Van Groenendaal (1989) shows that in many definitions (for example those provided by Bosman & Sol (1985), Thierauf (1982) and Ackoff (1967)) 'structured' problems are in one way or another seen as problems for which solutions can be quantified on the basis of a model. 'Unstructured' problems, then, are often seen as all problems which do not meet this criterion[19].

In my view, claiming that DSS do somehow deal with semi and/or ill-structured problems, and -more generally- the very use of the structured/unstructured dimension for classifying problems, decisions and CT, is somewhat problematic. First, and in line with Van Groenendaal's (1989:103) more general assertion, when looking at present-day DSS in agriculture, one gets the impression that the core activity of DSS developers is to *translate* so-called ill-structured problems into structured ones by means of modelling. This considerably blurs the distinction between for example MIS and DSS. My second reservation originates from the empirical material on diversity in farming, which shows that farmers effectively apply different models of thought for solving similar problems (see chapters 8 and 9). This means that these problems cannot be 'structured' into an unambiguous model (even if scientists have frequently attempted to do so). In fact, it can be argued that the very idea of 'structured problems' is closely affiliated to 'hard' systems thinking and/or first and second wave approaches in information systems research. My theoretical framework, then, seems to imply that 'structured problems' do not exist[20]. Both processes of defining, modelling and solving a problem are essentially social in nature, so that it is unthinkable that one could arrive at an unambiguous 'structuring' thereof.

Classifying CT on the basis of the various models incorporated in their 'internal' and 'external' design

Clearly, the implication is that it is of limited use to base a classification of CT on a structured/unstructured' (or a related) dimension, which leaves me with the need to develop alternatives. This quest is considerably complicated by my theoretical framework; the idea of making a classification in the first place is that one can somehow identify 'inherent' *characteristics* of CT, while my theoretical framework suggests that such 'characteristics' are socially negotiated in a specific context. In the extreme, this means that a given CT, when applied in different social context, may 'exhibit' rather different characteristics or 'structural properties'.

However, for pragmatic reasons I need some sort of a classification, if only to give the reader an impression of the range of CT that can be found in the agricultural sector. Furthermore, the classification must be flexible in that a given CT may have to be classified differently in different contexts.

The classification presented below is based on two theoretically inspired distinctions. First, my theoretical framework urges me to conceptually distinguish between the '*internal design*' of a CT, and its '*external design*'. With the term 'internal design' I refer to the software and hardware dimensions of a particular CT. That is, to its internal technical and software-technical design (e.g. hardware configuration, programming language, user-interface, etc.). The term 'external design', then, refers to the 'societal code' that any technology takes on in a particular social context. That is, to its normative and political dimensions, and the way in which it is organizationally embedded. Since such 'characteristics' are -in Giddens' definition of the concept- often intentionally built-in, and/or negotiated by active and knowledgeable agents, I think that the term 'design' is indeed appropriate, even if the outcomes pursued by individual actors (for example a CT-developer) may not actually materialize. This distinction between external and internal design is important because my theoretical framework posits that the social and organizational dimensions of CT (i.e. their 'social interface') are important constituent elements of such technologies, and moreover crucial factors for explaining their 'success' or 'failure'.

Second, when speaking about the design of CT, and about the 'contents' that are communicated with the help of them, I think that it is useful to distinguish between different 'models' that are more or less implicitly incorporated. The models that I distinguish are inspired by: (a) practical experience; (b) the types of anticipation problems that can be derived from the KIS perspective (see section 4.2); and (c) the idea that all knowledge (including that concerning the natural world) is socially negotiated. The types of 'models' that I found of use in distinguishing different types of CT are the following:

- models of human learning;
- models of the user, such as:
  . models of (future) information needs;
  . models of foreknowledge and support needed;
  . models of decision making and rationality;
- models of natural and technical processes, opportunities and constraints;
- models of socio-economic processes, opportunities and constraints;
- models of advisory/extension processes;
- models of communication patterns.

It is important to recognize that these interpretative models can have *normative* and *political* connotations. That is, the models incorporated in CT can, for example, very well express the developers' normative views on how users *should* learn, decide, perceive the natural world, etc., or the developers' ideas of which way of learning, decision making, interpreting the natural world, etc., is *wanted* in the context of certain political interests. In other words, they may not be purely rooted in how users *do* learn, decide, perceive the natural world, etc. On the basis of these distinctions, I arrived at a classification of CT which deviates considerably from the usual ones adhered to in the field of agro-informatics.

Feedback Systems (FS)
Feedback Systems (FS) are CT for the registration, storage, manipulation and representation of knowledge constructs which relate to particular actions and the outcomes thereof. That is, these systems have a potential to provide regular *feedback* on the consequences of one's own (and/or other actors') 'routine-like' behaviour. Also, users may fall back on such tools in case of unexpected problem situations.

The most elementary form of such a CT is a spreadsheet program (e.g. Lotus or Reflex), which incorporates very few of the above mentioned models. In essence, such a program consists of a matrix of columns and rows, of which users can define the contents themselves. Depending on their interests, users can (on the basis of algorithms of their own choosing) make calculations and selections, generate graphical representations, etc. In these instances, users have what one could call considerable room to *play around* with knowledge constructs. If one were to identify a model implied by spreadsheet programs, it would be the model of the capable, independent, creatively learning human being.

In practice, quite a few CT build on this basic idea, but are much more pre-structured than an 'empty' spreadsheet program. For example, in systems for enterprise registration and comparison (ERCS; see chapter 9), and also in what are often called Management Information Systems (MIS), one can see that the CT-developers have (with or without consultation of users) decided which knowledge constructs, representations, manipulations and algorithms are important. In addition to somewhat more directive models of learning, such FS clearly contain models of the (future) information needs of users as well. Furthermore, more often than not, such FS have normative and political connotations; for example, they comprise models of what the information needs of the users *should* be according to the CT-developers.

FS function frequently within larger organizations than farms, whereby they simultaneously provide feedback to multiple users at various levels in the organization. In such a case, we can speak of a combination between a Feedback System and a Networking System (NS; see further on).

Search and Access Systems (SAS)

A category of CT that incorporates mainly models of the user (information needs and foreknowledge) are Search and Access Systems (SAS). Like FS, SAS often consist of a database with facilities for manipulation, which -in these cases- are primarily geared towards searching. In contrast to FS, however, it is not the user who 'fills' the system with knowledge constructs, but the CT-developer. Thus, I am speaking about CT in which knowledge constructs concerning a specific domain are stored; for example, an automated telephone guide, a system for searching books in a library, or a database which encompasses all permitted medicines and/or remedies, including their characteristics, directions for use, points of sale, etc.

It will be clear that such SAS inherently imply a model of information needs, since choices need to be made with regard to the knowledge constructs that are included. As is the case with FS, such a model of information needs may have normative and political dimensions. At the same time, the searching procedures included in SAS must start from assumptions about the foreknowledge that users *already* have in order to be able to find the appropriate telephone number, book or remedy. In an ordinary Dutch telephone guide one can, for example, only arrive at a correct telephone number if one knows the alphabetical order, someone's community of residence and family name. In addition, an Englishman must know that one needs to search for Van den Ban under 'B' and not under 'V'. In an automated telephone guide too, such conditions and limitations always remain. The same holds, for example, for an automated library system; in many of these it is possible to search for books using author names, title words, year of publication, and/or UDC code, but impossible to search on the basis of citation index, publisher, university of origin, etc.

Advisory Systems for Independent Use (ASIU)

In contrast to FS, Advisory Systems for Independent Use (ASIU) generate specific *advice* or concrete guidance for future action. In the context of extension practice, one could also speak of Extension Worker Replacing Systems (EWRS). In its most simple form an ASUI contains a rather trivial *calculation model* with the help of which one can, for example, calculate how many bricks are needed to build a wall of 24 square meters. Many ASIU, however, comprise of much more complex calculation models. With the help of *simulation models* (for example a crop growth model), it is possible to make projections on the basis of hypothetical interventions, whereby usually such simulations result in an evaluation or advice concerning the desirability of specific interventions. Other ASIU encompass *optimization models* (for example a model for solving logistic problems), which -by means of, for example, linear programming or other operations research techniques- generate advice on the 'optimal' allocation of means, given some previously defined set of objectives. A third type of model which frequently underlie ASIU are *diagnostic models* (for example a model for diagnosing and remedying diseases); often such ASIU attempt to arrive at a diagnosis of a specific problem situation with the help of an interactive 'dialogue' between user and the CT. A considerable number of diagnostic ASIU make use of 'artificial intelligence' techniques (see section 3.1).

Most obviously, ASIU usually incorporate models of natural, technical and/or socio-economic processes, opportunities and constraints. However, in all these CT arriving at an 'advice' (i.e. in the form of an evaluation of a projection, an optimal solution, or a diagnosis) implies both the use of a certain mode of argumentation, and a specific procedure of interaction between CT and user. Therefore, such ASIU inherently imply a certain model of rationality, and consequently suggest a specific procedure of decision making. In addition, like FS, ASIU start from models of information needs since certain knowledge constructs and relations are deemed relevant or irrelevant for generating an 'advice'. In cases where ASIU prescribe what -ideally- should be the decision-making procedure and/or information needs of a user, it is clear that they are grounded upon normative models and/or political interests as well. Finally, ASIU often incorporate a rather directive model of learning since -in most cases- it is the system that produces an analysis and/or a solution. In those instances where ASIU facilitate users to 'experiment' with particular interventions, the emphasis is more on 'experiential' learning. It must be kept in mind, however, that these types of complex models do in most cases remain a 'black box' for the user, which means that the outcomes are often hard to control and/or comprehend.

Advisory Systems for Supervised Use (ASSU)
The main difference between an Advisory System for Independent Use (ASIU) and an Advisory System for Supervised Use (ASSU) is, that in the former there is no external advisor/supervisor who directly interferes with the farmers' use of the CT, whereas in the latter case there is. Thus, one could say that the ASIU and ASSU differ in certain aspects of their external design, most notably the way in which they are organizationally embedded. In other words, they incorporate different models with respect to the user's foreknowledge and support needed. While such a user model is virtually absent in case of ASIU (that is, support is restricted to a unique introduction of the user with the ASIU and/or the workings of a computer), it is assumed in case of ASSU that users need 'permanent' supervision and help in working with this type of CT. This distinction implies that CT that are identical in terms of their internal design, may in one context be termed an ASIU, whereas in another it must be labelled an ASSU.

In the context of extension practice, we can further divide ASSU into Extension Worker Support*ing* Systems (EWS*G*S) and Extension Worker Support*ed* Systems (EWS*D*S). At first sight, the distinction between EWSGD and EWSDS seems not very sharp either; it is essentially a historical and contextual distinction with a conceptual dimension. In fact, one can look at Extension Worker Support*ed* Systems as 'failed' Extension Worker Replacing Systems (EWRS or ASIU); the designers intended to make a system for independent use, but gradually realized that the 'would-be ASIU' did not function satisfactorily. Subsequently, extension and supervision facilities were provided for purposes of *correcting* the user and/or CT. In agriculture there are unfortunately quite a few systems with such a history. In contrast to EWSDS, Extension Worker Support*ing* Systems were developed in order to function in direct extension worker/client interactions from the outset, which in principle allowed CT-developers to explicitly anticipate such a context. In other words, ASSU incorporate different models of advisory/extension processes than ASUI; whereas in the latter cases it is assumed that adequate advice can be given in interactions mediated only by CT, it is believed in the former that more direct forms of human communication are needed as well. Moreover, there are differences between EWSGS and EWSDS in this respect as well.

In the case of EWSGS, it is assumed that both the extension worker and the client are users, and that it is the *interaction* between the two that needs to be anticipated and supported. (It frequently happens, however, that *only* the extension workers are considered to be users; in such cases one could probably safely say EWSGS incorporate an inadequate model of extension processes.) In the case of EWSDS, the extension worker is basically seen as someone that needs to correct the 'shortcomings' of the CT and/or user.

Although it may, in actual practice, be difficult to distinguish between EWSGS and EWSDS, the distinction is not only of conceptual relevance. In specific contexts, for example, the question must be seriously addressed whether or not it is sensible to use a 'failed' ASIU as EWSDS. After all, ASIU are often developed in order to replace other extension media, and/or alleviate certain extension tasks. If, however, such a CT is likely to result in *additional* extension tasks, one may be putting 'the cart before the horse'.

Networking Systems (NS)

When speaking about computer networks, the first images that come to mind are the physical infrastructures (glass-fibre cables, telephone lines, central computers, servers, etc.), and the network software which is necessary in order to link a large number of computers, and make sure that they are able to 'talk' with each other and share software. By logging in to a computer network, however, a user cannot only access all sorts of FS, SAS, ASIU, and ASSU, but he or she can also utilize special network facilities which I will label Networking Systems. Such networking systems purposefully capitalize on the opportunities for fast and a-synchronical communication within the network. A well-known example is Electronic Mail (E-mail), which is used by a large number of scientists (but also environmental and peace activists) from different parts of the world in order to contact each other and/or coordinate their activities. Other examples are bulletin-boards, systems for enterprise registration, exchange and comparison (see chapter 9), electronic conferencing systems, electronic provisions for the exchange of rapidly changing (and updated) weather forecasts, market and/or stock exchange reports, etc.

A special category of Networking Systems are Network Transaction Systems (NTS). The use of NTS initiates certain transactions concerning goods, services and/or money. For example, systems for the ordering or sale of goods and services (buying animal feed; ordering semen of a particular bull and someone to come by to inseminate it), electronic banking, etc. Frequently, such transactions are automatically processed in the administration and planning of those involved; thus, they are inherently connected with Integrated Chain Management.

Computer networks frequently have not only a large number of users, but also many suppliers of services. This means that -like in a SAS- a user needs to be able to find a way through the opportunities offered. Thus, in NS too one often finds searching procedures. In addition to the models of the user which are thereby implied (especially models of information needs and foreknowledge), such systems tend to be based also on a model of the communication patterns which users exhibit. It is apparently assumed that NS and NTS add something to the existing patterns of communication (and transaction) of the persons and institutions involved. The idea that a CT adds something to existing communication practices holds for other types of CT as well, but -in contrast to NS- it usually centres on a particular type of relationship (e.g. the one between extension workers and farmers), rather than on the pattern of relationships in an entire network.

The 'coordination systems'[21] that Winograd & Flores (1986:157-162) envisage (see also section 2.2) are in many ways Network Systems which are explicitly aimed at playing an coordinating role within a 'network of recurrent conversations' (i.e. a communication pattern). These systems are an example of a cross-breeding between FS and NS that I have already referred to when discussing FS.

It must be noted that CT do not necessarily include only algorithms, decision rules, databases with texts and/or numbers, etc. Virtually all types of CT can also encompass audio-visual representations. An ASIU or SAS for crop-protection may, for example, include pictures of specific diseases. Similarly, the results of a simulation in ASSU may be presented with the help of spoken language and/or with the help of moving pictures. Moreover, NS may very well include video conferencing facilities and the like.

7.4 Dominant methods for the development of communication technologies in primary agriculture

Someone who wants to develop a CT is confronted with numerous methods which differ with respect to their function, underlying philosophy and/or theoretical orientation. At the functional level several categories of methods are distinguished (see e.g. Bots et al., 1990; Bemelmans, 1987), of which Bemelmans (1987:135) provides a rather handy overview.

Figure 7.1: Different categories of methods (translated from Bemelmans, 1987:135).

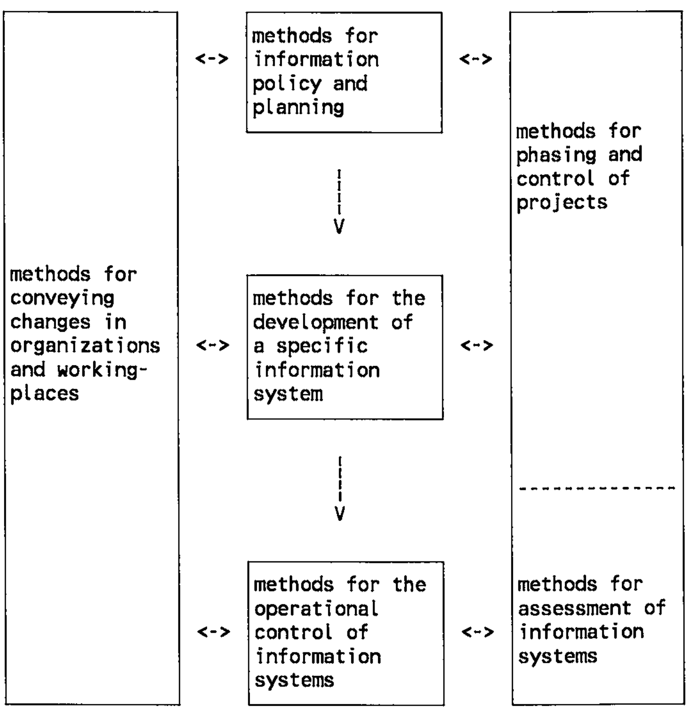


Table 7.9: Summary of presence and/or characteristics of 'models' which are frequently incorporated in different types of management supporting CT in Dutch agriculture.

	FS	SAS	ASIU (or EWRS)	ASSU (type EWSDS)	ASSU (type EWSGS)	NS
Models of human learning	creative or directive model of learning		rather directive model of learning	rather directive model of learning	rather directive model of learning	
Models of information needs	potential for user determined flexibility	flexibility through searching and selecting	often rather fixed model of information needs	often rather fixed model of information needs	often rather fixed model of information needs	flexibility through searching/ selecting/editing
Models of foreknowledge and support needed	capable user interprets independently	specific fore-knowledge needed for searching-procedures	user interprets independently	user needs support for 'proper' interpretation	user needs support for 'proper' interpretation	specific fore-knowledge needed for searching-procedures
Models of decision making and rationality	aimed primarily at exploration	aimed primarily at exploration	specific model included	specific model included	specific model included	
Models of natural and technical processes			specific model included	specific model included	specific model included	
Models of socio-economic processes			specific model included	specific model included	specific model included	
Models of advisory/ extension processes			mediation by CT suffices for generating adequate advice	extension agent corrects CT and/or user	purposefully built-in model of extension processes	
Models of communication patterns						specific model included

Although Bemelmans' categorization of methods is of conceptual relevance, in practice the different categories overlap. Also, emphasizing the importance of matching the different categories of methods (as Bemelmans (1987:136) seems to do), perhaps over-stresses their 'independence'[22]. Nevertheless, I will use Bemelmans categorization of methods, and take the central box in figure 7.1. as the starting point for a discussion of the different types of methods for CT-development. In some cases, I will also focus on aspects of such methods which clearly relate to the other categories of methods in figure 7.1. Afterwards, I will elaborate on the methods which have played an important role in the development of CT in Dutch agriculture.

'Process-oriented' versus 'data-oriented' methods

An important and frequently made differentiation is that between *'process-oriented'* and *'data-oriented'* methods for CT-development. Underlying these different approaches are dissimilar theoretical convictions concerning the stability of 'data' in an organization. Data-oriented methods are essentially based on the idea that 'data' in an organization are more stable than the 'data-processing processes' (or 'activities') which users are engaged in, in order to satisfy information needs (Bots et al., 1990:218; Bemelmans, 1987:140). Even if data-oriented CT-developers cannot escape looking at processes for the identification of relevant data, the idea is that users in an organization utilize a rather fixed set of these through time. Thus, the emphasis in data-oriented methods is on designing an overarching database with important data, which can be commonly used by members of an organization. Underlying such a database is a 'data model' in which (types of) 'entities', 'relationships', and 'attributes' are meticulously identified and defined. The development of CT in order to support certain processes or functions is of secondary importance, since it is assumed that -through time- members of an organization will use the same data for different functions and processes (Bots et al., 1987:218). Well known data-oriented methods of CT-development are several strands of Information Engineering (IE) (Martin, 1982; Finkelstein, 1989).

In contrast to data-oriented methods, the emphasis in process-oriented methods is not so much on developing a database for common usage, but on providing an organization with a range of CT which support specific organizational processes. To this end, processes and problem fields are identified for which specific CT can be developed, each with their own particular 'process model' and 'data model'. A popular process-oriented method is Information Systems work and Analysis of Changes (ISAC) (Lundeberg et al., 1982).

'Object-oriented' methods

A relatively new approach towards CT-development consists of so called *'object-oriented'* methods (Kristen, 1991; Bartels-Mertens et al., 1992). In many ways, object-oriented methods for CT-development not so much reflect a different philosophy concerning the importance and stability of data and/or data-processing processes, as they first and foremost mirror a different view of programming in a narrower technical sense. In a conventional CT, the program-code for the functions it performs is separated completely from the data, which leads to a variety of problems in relation to maintenance and/or adaptation of complex CT. When, for example, a simple data definition needs to be changed, it is a very time-consuming exercise to identify all the pieces of the program-code that need to be changed accordingly (see Ramackers & Van der Kuil, 1990:1024-1025). In an object-oriented program, data-oriented and process-oriented dimensions of an 'object' are integrated with each other in a separate module. An 'object', then, is an abstract concept which refers to a thing or element in 'reality' to which certain characteristics, properties and 'behaviour' are attributed. Thus, an object-oriented program consists of a large number of independent modules (each consisting of particular variables and related routines), which relate to each other only by the exchange of 'messages' (i.e. requests for performing routines on certain variables). Since other modules in a system can never directly process data from a particular module, it is relatively easy to alter its internal structure (Ramackers & van der Kuil, 1990:1025).

'Project-oriented' methods
A fourth type of method of CT-development can be labelled as *'project-oriented'* (Bots et al., 1990). Basically, such methods focus on the management of unique CT-development processes. Thus, their primary concern is the top-right box in figure 7.1, which is why they can usually be easily combined with data-oriented and/or process-oriented techniques. An important aspect of many project-oriented approaches towards CT-development is a phasing of the development process that resembles those of formal decision-making models, i.e.: (a) reconnaissance; (b) problem identification; (c) identification of alternatives; (d) choice; (e) preparation of implementation; (f) implementation; (g) maintenance; (h) evaluation, etc. In the context of CT-development projects, this is often translated into: (a) feasibility study; (b) functional design; (c) technical design; (d) building/implementation; (e) introduction/ utilization (Bots et al., 1990:37). It is assumed that adopting such a systematic approach towards CT-development will result in both better decisions with regard to the technology under construction and a more efficient development process. In the Dutch context, the frequently used project-oriented method is System Development Methodology (SDM) (Turner et al., 1988).

'Socio-technical' methods
Yet another set of methods is referred to by Bots et al. (1990) as *'people-oriented'* or *'socio-technical'* in nature. In a way people-oriented methods of CT-development resemble the project-oriented approaches in that both show a concern for procedures and management of CT-development processes. However, while project-oriented approaches stress systematics and efficiency, people-oriented methods emphasize the importance of user-participation, job-satisfaction and quality of work rather than efficiency in a narrower sense. Basically, it is attempted in these approaches to integrate the design of 'technical' systems with that of 'social' systems. Thus, in these approaches attention is paid not only to the central box in figure 7.1, but also to the left and top-right boxes. An example of these approaches is Checkland's (1981) Soft Systems Methodology (SSM). Other approaches are Effective Technical and Human Implementation of Computer Systems (ETHICS) (Mumford & Henshall, 1979) and Socio-Technical Approach to Automation-problems (STAA) (Kranendonk, 1986).

Prototyping
Finally, I would like to present *'prototyping'*-methods as a distinct approach towards CT-development. Most of the above mentioned approaches encompass a relatively extensive period of preparation and functional design (in which users may or may not play a role), after which the programmers retire to their rooms and 'lock themselves up' until (a part of)

the CT is more or less finished (even if it might need some testing and minor adaptation). According to Vonk (1990), such methods -which he refers to as 'structured methods and techniques' (Vonk, 1990:17)- :

> "fall short as a language of communication between developers and users, and often pay no attention to modelling the user interface of a system. Further, traditional analysis methods do not sufficiently anticipate the evolution of the information needs which takes place as users gain experience with the system" (1990:17).

He therefore suggests a much more iterative method in which -on the basis of a rather rough analysis and specification of requirements- developers start to build almost immediately an equally rough working model of the CT. The prospective users, then, are asked to test and evaluate this working model. On the basis of their comments and discussions, the developers can develop a new working model; a procedure which repeats itself until a 'final' and satisfactory version is obtained. Such a method is labelled by Vonk as 'prototyping'; that is:

> "an approach for establishing a systems requirements definition which is characterized by a high degree of iteration, by a very high degree of user participation in the development process and by an extensive use of prototypes" (Vonk, 1990:22).

A prototype, then, is: "a working model of (parts of) an information system, which emphasizes specific aspects of that system" (Vonk, 1990:20). According to Vonk, prototyping should not be confused with either 'evolutionary development', nor with 'end-user computing', 'incremental development' or 'participatory development'[23].

The making of Standard Information Models (SIM) for primary agriculture

An important element in the INSP-LV policy was the development of Standard Information Models for each branch. These models supposedly reflect the 'information household' of farms belonging to the branch and were central elements in the INSP-LV strategy to ensure compatibility and standardization (see sections 2.2 and 7.1). Moreover, their development was deemed important for both composing a corpus of agricultural knowledge on the basis of which CT could be built, and identifying gaps in existing knowledge (Brands et al., 1987).

As a result of apparently positive earlier experiences within the Ministry, the agricultural branch organizations were to use the Information Engineering Methodology (IEM) developed by James Martin Associates for the generation of Standard Information Models. Although Information Engineering (IE) has rather strong data-oriented connotations (see e.g. Finkelstein, 1989; Martin, 1982), some process-oriented and project-oriented elements can be identified as well. The James Martin Associates type of Information Engineering is a highly planned exercise, organized as a set of projects which are each composed of a number of steps. The first phase of IEM is called Information Strategy Planning (a method belonging to the top-centre box in figure 7.1), and it is at the same time its most process-oriented part.

I will not elaborate extensively on all the phases, steps and techniques belonging to IEM (see for more details Martin, 1982; Bots et al., 1990), but mainly present some of the results that have been achieved in the agricultural context.

The Standard Information Models developed for the agricultural branches essentially consist of a process model and a data model. In the process of IE both models are developed and specified in increasing detail. When both models have reached a certain level of detail, they are used to generate an 'information system architecture'; that is, an identification of the different 'information (sub)systems' and databases that are to be built, in order to meet information needs at different levels in an organization (Bots et al., 1990:837). When this variety of possibly useful 'information systems' has been identified, IEM proceeds to further specify the underlying models, make technical designs and eventually construct and implement the CT. Below, I will discuss above mentioned IEM products in a little more detail. The definitions used in the next section are derived from Bots et al. (1990:825-851).

The data model

In its most detailed form, an IEM data model consists of entities, relationships and attributes, which are all meticulously defined and described, and often visually represented in the form of so-called 'entity relationship' and/or 'entity relationship attribute diagrams'. 'Entities', then, are abstract or concrete 'objects' (e.g. a person, a bank account, an animal) of which it is deemed relevant to store data. Such data, which reflect a characteristic or state of affairs of an entity, are labelled 'attributes' of an entity (e.g. address, balance, milk yield), while the term 'relationship' refers to a particular connectedness between entities (e.g. a person 'opens' a bank account). In the earlier stages of IEM a data model usually has a higher level of abstraction, so that the model is composed of 'entitytypes' (a group of entities with one or more common characteristics, e.g. bank clients) or 'groups of entitytypes' (a grouping of entity types in a larger unit, e.g. a department for banking services) and 'relationshiptypes' (groups of relationships which represent similar types of connectedness, e.g. property relationships).

An example of such a data model (in the form of an entity relationship diagram) can be found in figure 7.2.; this particular data model is not a data model of a farm, but the data model of an extension organization.

The process model

The making of a process model usually starts with distinguishing a certain number of (primary) functions (i.e. contributions of a part to a larger whole of which it is a part) in an organization. These can be subdivided again according to either the entitytypes with which they are concerned, or the activities/processes which they constitute. Bots et al. (1990:639-640) demonstrate, for example, how the primary function 'banking services' can be subdivided into either (1) money-affairs, mortgages, insurances, payments and travels, or in (2) providing extension, making a quotation, concluding a contract and managing relationships. In the context of agriculture, the latter option has usually been chosen, which is why the term process model or activity model is frequently applied in this sector. A process model not only includes descriptions of activities, but also identifications of both the 'input information' (and its sources) that are (supposedly) necessary to perform the activities, and the 'output information' (and its destinations) that are produced in them (see for an example figure 7.3).

Figure 7.2: Data model of an extension organization. Source: MLV, 1986:4/9.

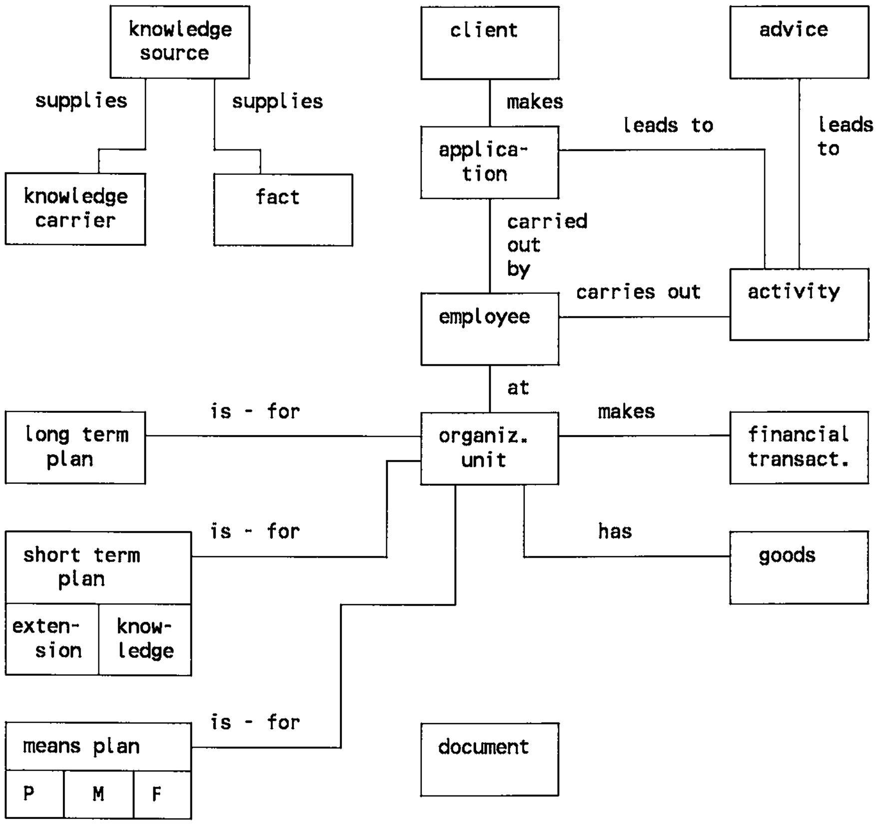


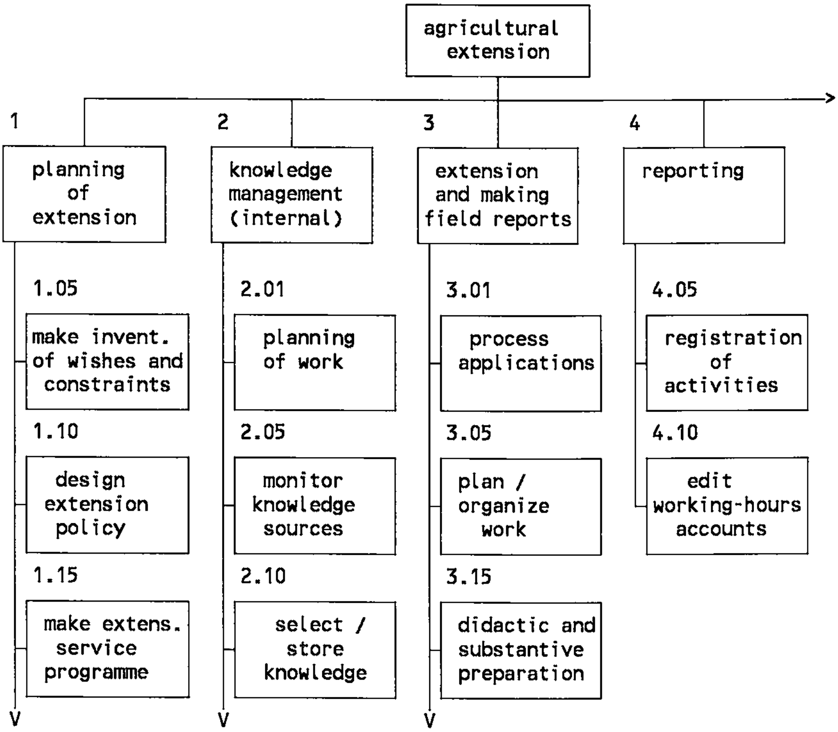
Figure 7.3: Overview of description, information input, output, source and destination of the activity 'select and store knowledge' in an extension organization. Source: MLV, 1986:appendix B.

from	input	activity	output	to
*	Professional journals (incl. Bedrijfsontwik.)	2.10 select / store knowledge	List of acquisitions	2.12
				2.15
2.05	List of knowledge sources		Table of contents archives	2.12
*	Policy documents			3.15
*	Information from organizations and industry			3.20
*	Information from institutes		Archives	2.12
2.15	Information from CAD, specialists, HVZ and BTD			3.15
2.01	Working plan CAD			3.20
3.15	Presentation material			
2.12, 3.25	Monthly reports/CAD news			

(* means: from outside)

A process model can be visually represented in so-called 'process decomposition diagrams' and in 'process interdependency diagrams'. An example of the former is presented in figure 7.4.

Figure 7.4: Part of an activity model or 'process decomposition diagram' of an extension organization. Source: MLV, 1986:4/3.



In a later stage of IEM, the activities can be subdivided again in 'elementary processes'; an elementary process, according to Brands et al. (1987:16-3), is "the smallest possible activity which can be executed as a whole" (transl. CL). At this elementary level, the descriptions of the processes depict in terms of data how the process (is supposed to) take(s) place; thus, it is at this stage where algorithms and/or decision rules are included in the model (Brands et al., 1987:16/4).

Arriving at an 'information system architecture'

In order to identify separate information (sub)systems, IEM proposes to first create an 'information architecture' in the form of an 'entitytype processes matrix' (or Create/Use (CU) matrix. In this matrix, processes are listed along the vertical axis[24], while entitytypes are specified along the horizontal axis. At the various intersections of the matrix, it is indicated whether information is 'used' (U) or 'created' (C); if neither of the two is the case, the intersection remains blank. An example of such a matrix is given in figure 7.5.; in this figure entitytypes are labelled 'data-groups', while processes are labelled 'activities'.

Figure 7.5: Part of an 'entitytype processes matrix' of an extension organization. Source: MLV, 1986:4/11.

1: long term plan
2: short term plan - knowledge
3: short term plan - extension
4: personal plan
5: material plan
6: financial plan
7: knowledge source
8: knowledge carrier
9: fact
10: client
11: application
12: employee
13: activity
14: advice
15: org. unit
16: goods
17: financ. transact.
18: document

ACTIVITIES	DATA-GROUPS											
	1	2	3	4	5	6	7	8	9	10	11	12
1.05 make invent. of wish. & con.												
1.10 input expected R&D results							U					
1.15 design extension policy	C											
1.20 make ext. service programme	U	C	C									
1.25 set posteriorities	U/C	U	U									
1.30 evaluate extension	U	U	U									
1.35 monitoring & control		U	U								U	
2.01 planning of work										U	U	U
2.05 monitor knowledge sources	U	U					C			U		U
2.10 select/store knowledge		U					U	C	C			
2.12 edit/adapt knowledge		U						C/U	C/U			
2.15 transf. & instruct knowledge		U					U	U	U			U
2.20 delete knowledge		U					C/U	C/U	C/U			
2.25 update farm data, etc.										C/U		U
3.05 process applications			U							C/U	C	
3.10 plan/organize work			U								U	U
3.15 didactic & substant. prepar.			U				U	C/U	U	U		
3.20 provide extension/advice			U				U	U	U	U	U	U
3.25 making field reports			U					C/U		C/U		
4.05 registration of activities			U							U		U
4.10 edit working-hours accounts										U		U
5.01 design ext. personn. policy	C											
5.05 make inventory & budget	U			C								
5.10 establish formation	U			C								
5.14 release vacancy				U								C/U
5.15 recruit/select/employ/fire				U								C
5.20 introduce and educate				U								U
5.25 supervise personnel				U								U

Figure 7.6: Part of an 'information system architecture' (or blueprint) for an extension organization. Source: MLV, 1986:6/3.

1: long term plan
2: short term plan - knowledge
3: short term plan - extension
4: personal plan
5: material plan
6: financial plan
7: knowledge source
8: knowledge carrier
9: fact
10: client
11: application
12: employee
13: activity
14: advice
15: org. unit
16: goods
17: financ. transact.
18: document

ACTIVITIES	DATA-GROUPS											
	1	2	7	8	9	3	10	11	14	13	4	12
1.05 make invent. of wish. & con.												
1.15 design extension policy	C											
1.25 set posteriorities	U/C	C				C				U		
5.01 design ext. personn. policy	C											
6.01 design material policy	C											
7.01 design fin. policy extension	C											
1.20 make ext. service programme	U	C				C				U		
1.10 input expected R&D results			U									
2.01 planning of work							U	U		C		U
2.05 monitor knowledge sources	U	U	C				U					U
2.10 select/store knowledge		U	U	C	C							
2.12 edit.adapt knowledge		U		C/U	C/U							
2.15 transf. & instruct knowledge		U	U	U	U							U
2.20 delete knowledge		U	C/U	C/U	C/U							
2.25 update farm data, etc.							C/U			U		
1.20 make ext. service programme	U	C				C				U		
1.30 evaluate extension	U	U				U				U		
1.35 monitoring & control		U				U		U		U		
3.05 process application						U	C/U	C				
3.10 plan/organize work						U		U		C		U
3.15 didactic & substant. prepar.			U	C/U	U	U	U					
3.20 provide extension/advice			U	U	U	U	U	U	C	C		U
3.25 making field reports				C/U		U	C/U		U	C/U		
4.05 registration of activities						U	U			C		U
4.10 edit working-hours accounts							U			U		U
8.01 organizational development							C/U					
8.05 stimulate other extension							C/U	U				
5.05 make inventory & budget	U									U	C	

On the basis of this matrix an 'information system architecture' is obtained by manipulating the order in which the entitytypes are listed. The principal aim thereby is "to minimize the magnitude and complexity of data-exchange between different systems. That is, maximizing (internal) connection and minimizing (external) coupling" (Bots et al., 1990:643) (transl. CL). To this end, the entitytypes are ordered in such a way that entitytypes which are created by consecutive processes are successively listed in the matrix as well, which implies that the C's will appear more or less on the diagonal of the new matrix. Finally, rectangles are drawn around particular segments of the matrix in such a manner that they encompass highly interdependent (groups of) processes and entitytypes. Each rectangle, then, represents a (potentially) distinct information (sub)system. The C/U intersections which fall outside the rectangles represent situations in which an entitytype is created and/or modified in one information system, while it is used in another (Bots et al., 1990:643-646). The result of such a 'clustering' procedure is illustrated in figure 7.6 (note that in this case the processes on the vertical axis have been slightly reordered as well).

Arbitrary artefacts?

Despite its seeming 'exactness', the above summary of how data models, process models and information system architectures are arrived at remains rather untransparent. Even if they require meticulous work, these artefacts seem -at first sight- to come out of the blue. The arbitrariness of process models (and thereby of data models and architectures has been demonstrated convincingly by Bots et al. (1990:649-657; see also Bots & van Heck, 1989:127-140). Departing from different management models, these authors show that totally different process models can be constructed for the same horticultural (sub)branch[25].

Apart from the apparent fact that the identification of functions, entities, relationships, attributes, processes, activities, etc., is by no means a straightforward and 'objective' venture, it can be argued as well that the whole IEM clustering procedure for the identification of distinct information (sub)systems seems to have little theoretical underpinning.

Beers (1991b:129-130) too, points to the 'subjective' dimensions of making a process and/or a data model, which result from the fact that IEM provides no unambiguous criteria for distinguishing and (sub)dividing processes, entities, etc. According to Beers this considerably hampers the reproducibility of Standard Information Models[26].

However, it would be misleading just to label artefacts, as discussed above, as simply arbitrary, since they clearly reflect a certain (social) rationale. Beers, for example, points to the normative dimensions of Standard Information Models. He argues that researchers and extension staff often regard (and I would add construct) Standard Information Models as a record of current agricultural knowledge (1991b:132). In relation to this they are not so much a reflection of common and empirically observable information households, but rather prescribe what such an information household would ideally look like, which in fact makes it impossible to establish their validity (1991b:128). In short, they tend to be normative blueprints for information provision (Beers, 1991b:132), which -when applied for the development of information systems- "create rather than describe a reality" (1991b:131; transl. CL)[27].

In the concluding section of this chapter I will come back to the social dimensions of Standard Information Models.

Standard Information Models in practice

While the making of Standard Information Models was delegated by the branch organizations to working teams of which almost all members originated from (semi)state research institutes, the actual realization of CT on the basis of these models depended largely on the private sector, since the branch organizations and research institutes were not supposed to engage in the commercial production of CT (see section 7.1). In the context of suggestions to use Standard Information Models for certifying CT (Klink, 1991b:15; Subnel, 1990:8), some agro-software firms have made efforts to base (elements of) their packages on the Standard Information Models. However, the impression is that most of them pay mainly lip-service to them. The reservations of private firms do not only stem from a wish to preserve enough commercial difference between CT of different origin, but also from practical and financial problems in applying them (see box 7.4).

Box 7.4: **The (coloured) considerations of a software developer**

As a software developer employed by a large feed-industry, Subnel (1990) describes and illustrates a number of practical and financial problems related to the use of SIM, some of which are summarized below.

- The practical usefulness of certain calculation rules and definitions agreed upon by SIM-developers is sometimes limited.
- The process of keeping a SIM up to date is very slow. In practice, therefore, agro-software firms have to, in their own, way fill up the gaps of SIM in the meantime. When eventually an up-to-date version of a SIM is provided, it is very costly to reorganize an existing CT again. In short: "in practice, the pace of maintenance and adaptation of management systems is higher than that of the adaptation of SIM" (Subnel, 1990:9; transl. CL)
- According to SIM, existing CT need -in order to allow exchanges within the production chain- to be adapted in such a way that they include variables which are of no direct relevance to farmers.
- Investments in time and money for adapting the data structures of existing CT are too high, slow down the inclusion of new services to users, and do not guarantee a financial reward for the user.
- The categorizations (of different functions, processes, entities, etc.) made in SIM do not coincide with distinctions made in the everyday practice of farming. When such a model would be implemented in detail, a CT might become very chaotic.
- The IEM leaves a number of questions unanswered, so that software developers cannot straightforwardly proceed to develop a CT on the basis of SIM.
- In practice, the IEM strategy to prevent redundancy (that is, to avoid duplication of data registration), is not always practical in that it tends to make packages slow.
- Although farmers increasingly find a certain amount of standardization and uniformity important, they are not very well informed about SIM. As long as a certain amount of compatibility is provided, they do not care about a full implementation of SIM; not least because it does not provide them with financial advantages.

Klink too points to counterproductive dimensions of INSP-LV standardization efforts, and speaks of a "dilemma" (1991e:9). He argues that timing of standardization is of particular importance. If standardization is enforced too early, further innovation is hampered since a half-grown approach is raised to standard. In the opposite case, the prospects to enforce standardization may be limited due to practical problems. Thus, Klink suggests a stepwise approach towards standardization, in which agreements on standards gradually arrive at a more detailed level[28].

Furthermore, Klink suggests that -amongst others in terms of their usefulness for making functional designs- the expectations with regard to SIM have been too high (1991e:7). An implication of this is that it will be impossible to certify CT on the basis of a detailed analysis of their internal design (as had been the initial intention), but only on the basis of a rougher evaluation of whether or not such a technology applies definitions and calculation rules correctly when looked at as a black box (which will suffice for ICM and enterprise comparison purposes) (Klink, 1991e:15). This would in fact coincide with the present practice that only (elements of) the data model (e.g. the data definitions) and calculation rules which are included in the process model, are frequently adhered to (Klink, 1991e:6; Raven, 1991:15-16).

The qualities of SIM in terms of their capacity to store agricultural knowledge have turned out to be less than expected as well. Although SIM have resulted in a more uniform use of concepts across disciplines, it is now recognized that they cannot simultaneously encompass all agricultural knowledge which has been developed from a variety of perspectives (Klink, 1991e:5; Raven, 1991:11).

Despite the various practical and theoretical limitations and shortcomings of SIM, they have probably contributed greatly to the development of CT in agriculture in the sense that the struggles and activities necessary for their development have shaped a community of agro-informaticians which share a common language, history, common interpretations, beliefs, ideologies, etc. In his evaluation study Klink (1991e:1-3) too prominently mentions 'organizational results' such as the fact that: (a) people have become conversant with the idea of systematically developing information systems; (b) it has become clear and accepted that there is a need to develop one 'integrated information system' for the 'agricultural entrepreneur'; and (c) that a large number of actors have been organized around a particular theme, which has resulted in cooperation and organization building.

7.5 Theorizing the broader context: structural properties, summary representations and intentional ignorance

Although the title of this chapter speaks of 'the broader context of ...', I could also have chosen to use terms such as 'the macro-context of ...', 'structural conditions for ...', 'the structural context of ...', 'structural properties associated with ...', etc. Hence, this chapter deals somehow with the 'structural setting' in the context of which later presented case-studies must be understood. In section 5.3, I have identified mutual knowledge (as connected with mutual ignorance) as the fundamental modality of structure. In relation to this, I have also embraced Knorr-Cetina's (1988:39) view of the macro as "a summary representation actively constructed and pursued within micro-situations".

In my experience, the written artefacts on which large segments of this chapter are based reflect in fact several of such 'summary representations' which are quite commonly drawn upon in micro-situations within the domain of agro-informatics.

Structural properties as an outcome of drawing upon common classifications in social practices

In the course of this chapter we have met with a number of classifications which are frequently used by agro-informaticians, i.e. classifications of:

- different agricultural (sub)branches;
- different categories of farmers;
- different types of CT;
- different categories and types of CT-development methods;
- different entities, functions, activities, etc.
- different categories of problems.
- different types of knowledge

The very idea of making a classification is in fact to 'summarize' 'reality'. Hence, such classifications (and the attributions that are made in relation to them) can be a useful entry point for identifying and discussing summary representations. Using common classifications in this manner, I will in the following sections discuss first the contents of specific categorizations and -in accordance with Giddens' theory of structuration- point to their theoretical, historical, political, ideological and/or normative dimensions. Although, given the nature of this chapter, it is difficult to directly demonstrate the practices and actions in which these classifications are drawn upon, I will attempt to identify such practices on the basis of the written material and my wider research experiences in the domain of agro-informatics. Of these practices I also hope to demonstrate the social dimensions. Finally, I will point to the 'macro' consequences which have emerged from the use of particular classifications; in other words, I will try to identify some 'structural properties'; that is, "institutionalized features of social systems, stretching across time and space" (Giddens, 1984:185), in relation to the world of agro-informatics.

The classification into different agricultural (sub)branches
As I have shown, agro-informaticians commonly subdivide the agricultural sector into several branches, i.e. the dairy, pig, poultry, arable farming and horticultural branches. Historically, this classification has developed alongside processes of increasing (and/or altering) specialization in agriculture, and it has replaced earlier classifications of farming systems (for example regional and/or soil type-related classifications; see Staring, 1870; Bieleman, 1992). Hence, the classification is related to both the prevailing conception that Dutch economic interests are best served with an increasingly specialized farming sector, and the related normative idea that a 'good' farm is a specialized farm.

The emergence of branch organizations exemplifies the fact that this classification has been drawn upon in networking and institution-building practices. Hence, many agro-informatics networks and institutions have become organized along branch lines. Already before the INSP-LV period this pattern of organization existed (e.g. in relation to research institutes, ministerial divisions, extension departments, service institutes, etc.) and existing institutions have used (and thereby reinforced and reproduced) the common classification in order to legitimize particular claims on INSP-LV resources. More than likely the classification has in these practices become imputed with additional normative (e.g. all branches should get a fair share) and political (e.g. representing a particular branch legitimizes access to resources) meanings.

Apart from the role this classification has played in networking and institution building, I have in this chapter touched on various other social practices in which it has played a part; schematically one could refer to them as *invisibilizing*, *inflating* and *explaining*.

In relation to invisibilizing it is interesting to note that the meaning of the word 'integral' (in the context of 'integral' MSS) has indeed come to relate only to the integration of management support functions concerning activities on *specialized* farms. No connotations whatsoever are implied in relation to the integration of such functions and/or activities on farms which, for example, have both a dairy and a pig unit. In fact, in the agro-informatics discourse mixed farms have not only been made invisible in the manner described above, but also by using LEI/CBS and EC criteria for calculating the number of farms per branch. Using these criteria results in relatively low numbers of farms per branch, and the subsequent opportunity to inflate percentages of CT-use (see section 7.2 and table 7.2). To the extent that such 'inflating' takes place (e.g. to legitimize claims for new subsidies) we can speak of a reinforcement of both the classification and EC calculation methods.

The classification has also played an important role in efforts to explain (and account for) the differences in CT-use and development between the branches (see section 7.2). In the process of doing so, specific characteristics are attributed to these branches and/or to the farms belonging to them. Although in some cases it seems that such characteristics (and explanations involving these) indeed make sense, many of the characteristics attributed to them seem to be rather arbitrary, ill-defined and inconsistently used (see boxes 7.5 and 7.6).

Box 7.5: **Some difficult questions**

Some questions that might be asked in relation to such characteristics and their explanatory potential (see section 7.2) are:

- Why is the 'production unit' of an arable farmer a crop or production plot, and why not a plant, a piece of machinery and/or a square meter?
- How does one assess whether the production units an arable farmer or a poultry farmer works with are less than those of a pig farmer?
- What exactly are 'production conditions', and are these really much more controllable on a pig farm than on an arable farm?
- How straightforward is the relation between controllability and the relevance of on-farm information; do arable farmers indeed use less on-farm information than pig farmers?

Box 7.6: **The importance of the nature of relationships in a wider (network) context**

The suggestion that 'the nature of the relation between user and CT-developer' can be an important element for explaining CT-use does indeed make sense, and is consistent with my theoretical framework. Even if common explanations in this respect often fail to further specify the relevant dimensions of such a 'nature of the relation', it is indeed clear that there are particularities in the relationships between for example: (a) pig and poultry farmers and animal-feed industries; (b) dairy farmers and veterinarians; (c) dairy farmers and accountancy bureaus; and (d) horticulturists and developers of climate computers, which indeed shape important aspects of the 'state of the art' of CT-use and development in the respective branches (see section 7.2). On the basis of both my theoretical framework and empirical observation, however, I would argue that the 'nature of the relation' must be understood in interpretative, normative and political terms, and moreover that one cannot fully understand these particularities and aspects by looking at these relationships in isolation from other relationships in time and space. One cannot, for example, adequately understand the relationship between veterinarians and dairy farmers without looking at the relationship between: (a) dairy farmers and animal feed industries; (b) dairy farmers and herd-book organizations; (c) veterinarians and herd-book organizations, etc. Thus, it is important to study the use and development of CT in the context of *networks of interaction* between various actors across time and space.

Despite the analytical weaknesses of these assumed characteristics, they are by now quite widely accepted. Thus, we see that the use of a particular classification helps to generate new (related) concepts and classifications which may become modalities of social structure as well.

In sum, it can be argued that the conceptual subdivision of the sector into different branches has had some very real consequences for, for example, institution building, the types of CT that are developed, the distribution of resources and the generation of new classifications and concepts. Thus, this summary representation lies at the root of certain structural properties that typify the world of agro-informatics.

The classification into different categories of farmers

I have shown that farmers are not only classified according to the branch to which they supposedly belong, but, within the branch, also into several other categories. Most notably these are the classification into 'frontrunners', 'followers' and 'laggards', and the subdivision into 'potential target-group' and 'non potential target-group' farmers. The first classification is based on supposedly stable characteristics with regard to the speed with which farmers adopt innovations and is further associated with all sorts of ideas concerning their analytical capacities, experimentation behaviour, attitudes, etc. (see section 7.2). The second classification seems -according to post-INSP-LV evaluation reports- to be based primarily on farm size and the supposedly related long-term economic viability. Both classifications are in fact connected in that many would argue that the 'potential target-group' consists of 'frontrunners' and part of the 'followers'.

Underlying both classifications, then, are specific conceptions about the nature of agricultural development, such as the idea that it is essentially a unilinear process towards scale enlargement and increased use of 'modern' technologies. This model of development has so many political and ideological dimensions that I will not even begin to outline them. Suffice it to say that the model is associated with mechanical and deterministic models of social change, and that a large amount of empirical material shows: (a) that agricultural development is by no means a unilinear process; (b) that different viable patterns of farm development exist; and (c) that existing classifications fail to deal with this strategic diversity (Bolhuis & Van der Ploeg, 1985; Van der Ploeg, 1990; Leeuwis, 1989b; Roep et al., 1991). Moreover, several studies have indicated that speed of adoption is not a stable characteristic (see e.g. Van der Ley & Proost, 1992), i.e. that it is problematic to speak of 'frontrunners', 'followers' and 'laggards' as fixed categories, as for example Klink (1991d:8) seems to do:

> "There is (...) an important distinction between the 'frontrunners' and the 'followers'. The 'frontrunners' experiment a lot, not only in the field of automation. 'Followers' take over successful approaches, but prefer to experiment as little as possible" (transl. CL).

Nevertheless, these 'old-fashioned' classifications are used, and obviously this is by no means accidental. As I have shown, the speed of adoption classification is used in relation to another subdivision, i.e. that of 'supply side' versus 'demand side' problems. In essence, the idea of 'demand-side' problems is utilized to *shift some of the responsibility* for the 'failure' of agro-informatics projects to the prospective users (user-blame). In this context, the speed of adoption classification proves instrumental for *constructing a particular 'model of the client'* (De Vries, 1992), in which the majority of farmers are pictured as non-experimenters, who have few analytical capacities, and who are in need of supervision and guidance by an external expert.

Box 7.7: **Modelling the farmer**

An earlier cited quote by Klink (1991a) illustrates this modelling beautifully:

"In certain situations the farmers' needs for parameters, etc. are satisfied in a different manner, so that a management system has a surplus value only when the agrarian entrepreneur feels a need to profoundly analyze the available information. It can be ascertained that with 'frontrunners' who are accustomed to experiment themselves, this need is always present. 'Followers' who do not experiment, need a discussion partner in order to further analyze parameters and comparable information, and draw conclusions that influence farming practice. Such a discussion partner might be a private or state extension worker, a field-staff member, a veterinarian or a colleague in a study club. The availability of such a form of regular supervision in the interpretation of available information, strongly determines the usefulness of the information, and thus the usefulness of the information system. Insufficient availability of supervision can therefore be another cause for the limited demand for management systems" (Klink, 1991a:10; transl. CL).

Thus, this speed of adoption classification and the characteristics attributed to the different categories, emerge as crucial elements in an argument which poses essentially (but implicitly) that 'failed' CT-projects can still become 'successful' if only a certain amount of supervision and extension is provided. That is, for *arguing* that no money has been wasted, as long as additional resources are provided. Obviously, alternative classifications which express strategic diversity and tend to picture farmers as almost inherent experimenters who employ modes of analyzing and reasoning which researchers, CT-developers and extension workers have not been able to capture and/or adequately value, would not fit well in such an argument.

In terms of structural properties, the reference to common classifications of farmers in above mentioned practices, has resulted in the phenomenon that both strategic differences between farmers within a branch, and the diverging information needs which may be associated with these, have become invisible. The same holds for smaller farms, in that they are not counted as belonging to the so-called 'potential target-group' (see table 7.2). Furthermore, the related presentation of agricultural development as unilinear and essentially science-driven has been instrumental for legitimizing both the development of Standard Information Models, and the dominant (normative) role which agricultural scientists were to play therein. More recently, it has resulted in the rendering of extension workers as indispensable actors for a successful introduction of CT; i.e. in terms of Callon et al. (1986) they are deemed 'obligatory passage points' (see section 6.3). These latter consequences are also related to an implicit classification into different types of knowledge, whereby scientific knowledge is considered to be superior to other types of knowledge.

In sum, we see once again that the use of these classifications has played a significant role in shaping the agro-informatics arena.

Classifications into different types of CT

When speaking of different types of CT, it is interesting to note that: (a) different categorizations of CT coexist, and (b) that there is a considerable amount of dynamism; classifications are frequently altered, altogether new categorizations emerge, new labels are invented, etc. At a higher level of abstraction the classification provided by Sol (1984) and Van den Herik (1988) (i.e. into ADP, MIS, DSS and ES) seems to be rather widely accepted among agro-informaticians, but in the day-to-day agro-informatics discourse a multitude of categorizations exist. At the more abstract level I have shown that the distinction between 'structured', 'semi-structured' and 'ill-structured' problems is an important underlying dimension for classification. At 'field level' we are often confronted with categorizations which have software and/or hardware technical or functional connotations. In section 7.3, I have already criticized the validity and usefulness of existing classifications, and tried to develop an alternative to these. At this point, however, I am primarily interested in the social practices with which they are connected, and in the role these classifications play in structuring the domain of agro-informatics.

It is of relevance to note that different classifications of CT are always connected with attributions and conceptualizations concerning the properties and characteristics of different types of CT. In the recent past, these properties have been perceived as being quite revolutionary, which is why they could become important in legitimizing government investments and intervention in the field of agro-informatics. In part, the steady flow of new classifications, labels, abbreviations and acronyms indeed reflect new technological developments, but in many cases they have to be seen in the context of marketing purposes, efforts to put oneself on the agro-informatics map and/or create an image of dynamism, or as endeavours to re-legitimize subsidies in the context of changing societal priorities and disappointing results[29]. In terms of Callon et al. (1986), it can be argued that agro-informaticians have enrolled several types of CT by suggesting that they exhibit certain characteristics and 'behaviours' which provide them with the potential to play crucial roles in the realization of certain scenarios. That is, they are 'obligatory passage points' for: (a) achieving Integrated Chain Management; (b) maintaining competitive advantages; (c) improving product quality; (d) achieving sustainable agriculture, etc. (see section 7.1).

Apart from these *legitimization* practices, I have shown that attributions and conceptualizations which are connected with particular categories of CT play a role in practices which one might label as *preventing criticism* and *measuring success*. The assumptions which underlie DSS, and most notably the idea that DSS support rather than automate decision making, for example, has provided CT-developers with the opportunity to disprove criticisms relating to the contents of CT by claiming that it is in the very nature of DSS that users do not follow DSS-advice. Thus, there are advantages in the labelling of a CT as a 'DSS', even if it does in no way reflect the original ideas underlying the concept. Similarly, I have suggested that the concept of 'Extension Worker Supporting System' too is an attractive label which is frequently used to redefine the nature of a CT when it appears not to function as expected.

Furthermore, it can be argued that the concept of MIS (as translated into 'integral' MSS in the agricultural sector) has not only been important for initiating the development of

Standard Information Models, but has also become a crucial element in evaluating the overall success of INSP-LV efforts, in that the 'number of personal computer based 'integral' MSS used' has become the leading criterion for such an evaluation. This provides agro-informaticians with, on the one hand, a self-created and perpetuated problem (namely, that on the basis of this criterion evaluations turn out less positive than if other criteria were used), and on the other hand, with a 'Leitbild' which they can continue to strive for, and in which they have invested so much effort and money that they cannot easily give it up without losing credibility.

We can conclude that the relatively stable use of CT-classifications at a more abstract level (e.g. DSS and MIS), combined with the more dynamic and diverse divisions employed at a lower level of abstraction, has helped to legitimize the initiation and continuation of government investments in CT-development. In this manner, the agro-informatics domain has obtained one of its most important 'structural' features, i.e. the fact that it is a heavily subsidized field of activity, that is organized as a set of projects with a rather clear criterion for measuring overall success or failure. For the evaluation of concrete CT, such classifications provide several 'escape routes'; that is, ways to (re)define the nature of the CT in such a way that criticisms can be dealt with without fundamentally changing the internal design of a CT.

Classifications into different entities, functions, activities, etc.
The development of CT often implies the use of classifications into entities, functions, activities, attributes, etc. Most visibly, these classifications can be found in Standard Information Models and CT based on these, but in fact they are inherent to most types of CT. By demonstrating the subjective and often normative aspects of such classifications I have already started to demonstrate some of the social dimensions of these (see section 7.4). In the context of INSP-LV activities, data models and process models have been constructed primarily by teams of scientists from various institutions, which has offered them the opportunity to design these in such a way that these models reflect *their* (and not necessarily farmers') views on what are -or should be- relevant agricultural and/or management activities, entities, functions, decision rules, etc (see also Beers, 1991b). That is, through these models scientists had an opportunity to *prescribe* and/or *impose* their models of thought on others. Given the fact that no unambiguous guidelines for making such classifications exist, we can assume that these models reflect a process of negotiation between the different actors involved. That is, we can suspect that the scientists involved have actively tried to get their personal and/or institutional interpretations concerning management and/or farming incorporated into such models.

Apart from these normatively and politically laden negotiations in processes of developing data and process models, larger issues of political and normative *steering* are at stake as well. Earlier on in this section, I have already argued that the development of SIM along branch lines is connected with particular politically and ideologically informed conceptions concerning the required directions of agricultural development. Now that these required directions are subject to debate, we can in the near future expect adaptations of existing SIM in such a way that they include activities, entities, attributes, decision rules, etc. which are deemed relevant for environmental protection and the realization of 'sustainable agriculture'. The fact that achieving a certain level of standardization by means of SIM was deemed important in the first place, reflects two other 'larger issues', namely that standardization was perceived as a necessary precondition for Integral Chain Management, and the conviction that farmers should not become too dependent on particular agro-software firms. Although perceptions on the level of required and feasible standardization have changed, these issues are still important, as is -for example- reflected in the branch organizations' intention to use (elements of) SIM for *certifying* CT, and the discussion this determination has evoked (Klink, 1991e; Subnel, 1990; Van den Broek, 1992).

Although the common classifications of activities, entities, attributes, etc. incorporated in SIM have in practice not been widely implemented in CT (see section 7.4), their existence is an important feature of the world of agro-informatics in that it plays a central role in a variety of debates, studies and projects that agro-informaticians engage in. In relation to this, the development of such classifications in itself has played an important role in the shaping of networks of agro-informaticians with a shared history, a common language, common beliefs, etc.

Conclusion

In the preceding sections I have identified a 'web' of interrelated classifications which are frequently drawn upon within the professional community of agro-informaticians. Some of these classifications (including the attributions made in relation to them) are quite explicit and frequently referred to explicitly, while others remain more implicit. I have shown that these classifications can be described as 'social' in a variety of ways. First, such classifications are frequently rooted historically in particular theoretical models, political convictions, ideological positions and normative evaluations. Second, I have made plausible that these classifications play a role in concrete social practices. In these practices, different actors actively draw upon such classifications in an effort to further certain political, normative and ideological interests. Thirdly, above described negotiation processes do not only constitute the (re)production of these classifications themselves, but they also have social consequences in that through these practices particular structural properties are (re)produced.

Box 7.8: **Identifying structural properties**

In sum, I have identified the following structural properties in relation to the domain of agro-informatics:

- the way it is financed (its highly subsidized character);
- its institutional organization (along branch lines);
- the nature of CT that are developed (unilinear, normative, specialized);
- its resource distribution (through projects, along branch lines);
- the type of organizational forms adopted (projects);
- the actors who are 'visible' and/or 'invisible';
- the actors who cannot be bypassed (scientists, branch organizations, extension workers);
- the artefacts that cannot be bypassed (SIM)
- the way investments are to be evaluated ('integral' MSS running on PC);
- the way criticisms are dealt with (escape and evasion routes);
- the issues (not) on the agenda;
- the way networks are composed;
- the concepts (not) used;
- the conflicts which exist (standardization, certification, false competition).

An interesting observation in this respect may be that, for a classification to play a role in the (re)production of structural properties, it is not a necessary condition that it is commonly accepted. Although, for example, the classifications made in SIM are by no means undisputed, it can still be argued that their history and existence has important structural consequences. Moreover, it might be argued that ongoing conflicts between particular actors in a social system can be regarded as structural properties as well. This observation illustrates that mutual knowledge (as defined by Giddens, see section 5.3) is not necessarily 'agreed upon' knowledge.

Finally, although I have not been able to directly document the use of classifications in specific micro-situations[30], I have reinforced the plausibility of my theoretical framework since it appeared possible to reconstruct how particular structural properties (might) have emerged from the continuous drawing upon particular summary representations in social interaction.

On classifications, structural properties and intentional ignorance

In chapter 5, I have stressed the inherent connection between mutual knowledge and mutual ignorance. Obviously, this position implies that mutual ignorance is inherently connected with summary representations and classifications (as a particular expression of the former) as well. Indeed, it is clear that the adoption of specific classifications in a particular context implies the exclusion of alternative classifications. To the extent that such alternative divisions and interpretations might have a relevant analytical potential, one could say that a certain amount of ignorance is created. In cases where particular classifications are systematically drawn upon, it can be argued that systematic areas of ignorance exist. Taking the argument one step further, one must conclude that, like classifications, areas of ignorance too are connected with: (a) historically rooted theoretical models, political convictions, ideological positions and normative evaluations; (b) political, normative and ideological struggles in concrete social practices; and (c) with the (re)production of particular structural properties. Thus, '*systematic*' areas of ignorance can be understood as *intentionally organized* ignorance; that is, certain areas of ignorance are -in Giddens' conceptualization of the term- *purposefully* constructed and maintained.

Intentional ignorance can, for example, be illustrated in relation to the classification into different categories of farmers. If the division between 'frontrunners', 'followers' and 'laggards' were to be dropped, and replaced by a farming styles classification (see chapter 8) the consequences would be quite dramatic. First, one would have to abandon unilinear models of agricultural development. Second, one would have to question both the contents of existing CT, and the idea that one CT can be developed for a whole branch. In fact, one might have to discuss the current division into branches altogether, including related institutional configurations. Third, the whole idea of strategic diversity jeopardizes the assumptions on which Standard Information Models have been based, and thus one would have to reconsider their usefulness (and re-evaluate the return on investments made). Fourth, embracing a farming-styles classification would considerably reduce the possibility to blame the users for the so far disappointing use of CT. Fifth, one would have to reconsider the role of scientists and extension staff in both the development and supervision of CT, and -more generally- in the process of agricultural development at large.

In short, accepting an alternative categorization at one point in a 'web' of classifications may result in the 'collapse' of a whole network of related concepts, classifications, interpretations, evaluations, etc., and therefore would run counter to a considerable amount of vested personal and institutional interests. Thus, the threatening consequences of alternative classifications may lead actors to purposefully ignore them, or -in other words- to intentionally organize ignorance. In chapter 8 I will demonstrate the significance of a farming-styles classification. Since this classification has so far been largely neglected by agro-informaticians, I will conclude that a certain amount of organized ignorance does indeed exist.

Box 7.9: **Parallels between CT-development in the North, and development efforts in the South**

In the context of development efforts in so called 'Third World' countries, forms of organized ignorance have been discussed by Arce & Long (1987) and Quarles van Ufford (1990). Interestingly, there are a number of striking parallels -in terms of structural properties- between the domain of agro-informatics and the arena of agricultural development efforts in the Southern regions of the world. In both societal realms we have to do with: (a) heavily subsidized development activities; (b) projects as the dominant organizational form; (c) cultural discontinuities between 'experts' and farmers, etc. Also, the two domains are characterized by rather similar dominant conceptualizations and classifications from which these properties emerge, and in fact with partly analogous areas of ignorance. Given the often central position which Northern 'experts' and donors play in both domains, these parallels between 'high-tech' communication technology development in Northern regions and technology development in Southern regions are not too surprising.

Instances of systematic ignorance have been discussed in studies concerning rural development and/or extension (Arce & Long, 1987; Long & van der Ploeg, 1989; Quarles van Ufford; 1990; Wagemans, 1987; Leeuwis, 1989b) but also by computer scientists (Winograd & Flores, 1986) and political scientists (Schaap et al., 1990; Van Twist & Schaap, 1991). Like Winograd & Flores[31], the latter base themselves on theories concerning autopoietic systems, and particularly on Luhmann's (1982, 1984, 1986) translation of Maturana & Varela's (1980, 1984, 1989; see also section 3.3) original work with respect to social systems (rather than 'living' systems). Following Luhmann, Schaap et al. (1990) speak of self-referential processes of reproduction in social systems. Luhmann (1984:346ff) argues that human minds (psychic systems) are operationally closed in that every new reflection builds on previous ones. Likewise, in social systems every communication builds on previous communications which is why they are essentially closed as well.

The notion of self-referentiality seems indeed important for the understanding of knowledge and ignorance. I have shown, for example, that new classifications and concepts are developed on the basis of particular, previously existing, classifications, which paradoxically implies an 'increase' in both knowledge and ignorance. In the context of societal steering problems, Schaap et al. (1990) and Van Twist & Schaap (1991) too make a link between self-referentiality and -even if they do not use the term- certain types of ignorance, in their case the limited capacity of organizations to adapt to changes in the environment. However, in contrast to both Schaap et al.'s and Luhmann's approach, I prefer to perceive self-referential phenomena as inherently embedded in social interactions in which areas of knowledge and ignorance are *actively* and intentionally constructed[32].

The potential of project evaluations as institutionalized forms of self-referentiality
In many instances project evaluations can be regarded as institutionalized forms of self-referentiality for the following reasons. First, such evaluations are usually carried out with reference to both: (a) the classifications and concepts which were used in the original project proposal, and (b) the goals that had been formulated in it. Second, even if 'external' evaluators are invited, they tend to be recruited from the same social networks as those in which the initiators of projects are involved. If executed exclusively in the manner described above, I would argue that project evaluations are to a considerable degree self-referential.

Practices as mentioned above can be regularly observed in both the domain of agro-informatics and the realm of international development cooperation. In the world of agro-informatics this is best exemplified in the series of Post-INSP-LV studies to which I have referred frequently in this chapter. These studies, which were partly carried out along branch lines, were financed by the Ministry and delegated to three private consultancy firms, all of which had important activities in the field of agro-informatics previous to their involvement in the post-INSP-LV studies. Although the studies were primarily issued to help the Ministry to prepare a post-INSP-LV policy, they almost necessarily turned out to have a highly evaluative character in relation to INSP-LV. Next to policy options, the studies provide a number of analyses and inventories in relation to the present state of the art of CT use and development in agriculture. Thereby, the studies explicitly start from the original INSP-LV goals (Klink, 1991a:3).

Apart from being carried out by consultancy bureaus which already had a number of linkages with INSP-LV projects, the research methodology consisted mainly of interviewing 'experts' in a particular field and/or branch. Moreover, in an explicit attempt to arrive at widely supported recommendations and problem definitions, draft versions of the reports were discussed with them as well. These 'experts', then, were almost exclusively employees of branch organizations, research institutes, extension organizations, and agro-software firms; in other words, active participants in agro-informatics networks.

Thus, when applying the criteria listed in the beginning of this section, one must conclude that self-referentiality has been built-in into INSP-LV evaluations. With reference to my earlier discussion in chapter 5, it can be argued that this phenomenon can be much more suitably understood in terms of Giddens' theory of structuration than in terms of Habermas' theory of communicative action. To a certain extent the whole Post-INSP-LV exercise was indeed a critical communicative effort to generate a shared definition of the situation, which, given the consensus on solutions achieved (see section 7.2), was quite successful. Although the evaluation process certainly involved argumentation concerning various types of validity claims, my discussion in this chapter (and also in chapter 2) has made plausible that this has been a rather selective phenomenon. In order to ensure particular outcomes of the debate, particular claims and arguments were left untouched. In that sense, one could argue that the actors involved have -by means of constructing certain areas of both insight *and* ignorance-strategically manipulated the outcomes of the evaluation study with the view of reducing responsibility for failures and securing future financial support from the Ministry. To ask whether this series of evaluation interactions consisted primarily of communicative actions or strategic actions (in Habermas' terms), and/or how the procedure as a whole can be interpreted in these terms, would in my view only lead to confusion. In Giddens' terms, however, it is much easier to understand that these evaluative interactions simultaneously had 'communicative' and 'strategic' dimensions.

Notes

1. Such CT, for example, calculated the minimum required diameter for milk pipes or the material requirements and estimated costs for paving a certain farmyard.

2. See for a critique of the assumptions underlying such programmes Winograd & Flores, 1986:133-139).

3. At the initial closing date of INSP-LV (1988; INSP-LV was later prolonged until the end of 1991), 6.5 million had been allocated to branch organizations (see later on), 4.2 million to the development of information models, and 10.5 million to demonstration projects; the remaining 20.1 million guilders were to be spent in the 1988-1991 period (CLO, 1988:26).

4. Although Blokker (1991) confirms that a certain level of automation at farm-level is a precondition for achieving effective ICM, he also emphasizes that agribusiness will -in order to obtain cooperation from farmers- lower financial barriers for farmers to invest in CT, and provide additional services to farmers which -if looked at in isolation- would not be viable. Thereby, he suggests that ICM can also be a precondition for the increased use of management supporting CT.

5. Despite the 'agreement' that branch organizations would abstain from the commercial marketing of CT, several branch organizations have been involved in the exploitation of such technologies. This practice has created tensions between the branch organizations and agro-software firms. In chapter 10, I will present a case-study in which these tensions play an important role.

6. SITU for horticulture, SIVA (already since 1980) for pig farming, TAURUS for cattle and dairy farming, SIPLU for poultry farming and SIVAK for arable farming.

7. After the termination of INSP-LV funding in 1992, the branch organizations were amalgamated in the Agrarian Telematics Centre (ATC). This institution will be subsidized by the Ministry for a few years, and will then have to be funded by the market sector itself. The Ministry will stop to subsidize individual projects; from 1992 onwards this has been an ATC responsibility.

8. That is, research projects other than those involving the making of Standard Information Models, which were mainly financed through the 'market sector' budget.

9. In a draft version for the next Plan of Action (INSP-LO, 1987:5) the refusal of the earlier Plan of Action is attributed to: (a) the uncertain position of the Service for Agricultural Research (DLO) within the Ministry; (b) doubts concerning the (insufficient) involvement of the market-sector; and (c) a rather concise presentation, which (incorrectly in the opinion of the authors) suggested a lack of cohesion.

10. The overarching themes were the following: (a) information technology and the enterprise-organization and -practice at agricultural and horticultural enterprises; (b) the consequences for extension and education; (c) information technology and the agrarian structure (INSP-LO, 1987).

11. Due to the particularity that the Department of Extension Science (which had been involved in formulating some of the fourteen social scientific project proposals) had already obtained funds for employing a researcher from the Agricultural University, the Service for Agricultural Research (DLO, which was responsible for distributing available funds) donated 25,000 guilders to this 'researcher without research budget' for carrying out some of the empirical studies which are discussed in this book. In part, this donation has to be seen in the context of the annual end-of-year effort to get the budgets spent as well. I have no information about other social scientific projects which may have been subsidized in this (or another) manner.

12. Both the costs for the breeding module (Steer Advisory Program, SAP) and the feed advisory package (Coupling Milk Inspection Cattle Feeding, KMV) are farm size dependent, and -for an enterprise with 50 cows- amount to a yearly fl. 112.- for SAP and fl. 187.50 for KMV (1988 prices). For SAP, an initial investment (fl. 13.60 per cow) needs to be made for an exterior inspection of each participating cow.

13. Klink (1990a:12) refers to 2,000 participating dairy farmers.

14. Overbeek (1992) argues, for example, that the economic results achieved by dairy farmers who use CT of various kinds do not differ from those who do not.

15. Although Verstegen et al.'s longitudinal study makes plausible that pig farmers who started to use 'integral' MSS between 1983 and 1992 reach higher numbers of piglets per sow per year in 1991 than those who did not, it is less clear how this quantitative relation must be interpreted. It may, for example, very well be that increases in piglet numbers are associated with other changes in management practices that have occurred simultaneous to the introduction of MSS, e.g. increased use of extension services and/or participation in study clubs.

16. Process automation operates at a purely operational level, while TEA are suited for medium and long-term evaluation. According to Hilhorst & De Visser, 'integral' MSS can play an intermediary role and link the two.

17. Such compatibility between ESS and other MSS would imply the realization of a shift -advocated by Klink (1990b)- in the relation between CT provided by extension services and those provided by others. In relation to dairy farming Klink argues that: "If one wanted to encourage a better use of available information among dairy farmers -whereby the need to be able to do so on one's own integrated management system and PC would increase- one would need a different positioning of information products and extension. Extension organizations and others will then have to sell extension, and base this on automated information. This means a reversal of the present relations; for example: in such a situation the DLV does not provide extension on and with an information product of the NRS [the cattle herd-book organization, CL], but the NRS provides data to dairy farmer and DLV on behalf of an extension product of DLV" (Klink, 1990b:28, transl. CL).

18. Simon (1977) has introduced the distinction between programmable and non-programmable decisions, which, as Van Groenendaal (1989:100) points out, has been translated into structured and unstructured problems by Gorry & Scott Morton (1971).

19. Van Groenendaal (1989:100) quotes Thierauf (1982:66) who states that "a decision is well structured if the decision maker can identify all the elements of the decision process and quantify them for determining the answer."

According to Van Groenendaal (1989:101), Bosman & Sol (1985) consider a problem to be well-structured when: (1) the set of alternatives regarding possible ways to allocate means (action alternatives) is finite and identifiable; (2) the action alternatives are consistently derived from a model (system) that shows a good correspondence; (3) the effectiveness or efficiency of the action alternatives can be numerically evaluated.
Ackoff (1967) "distinguishes three types of managerial decisions based on the possibility of (i) constructing an adequate model and (ii) deriving a (near) optimal solution. If (i) and (ii) are met it is a structured decision, if (i) is met a semi-structured decision and the situation where neither (i) nor (ii) is met can be identified as unstructured decision making" (Van Groenendaal, 1989:101).

20. Due to my theoretical and practical reservations with regard to 'soft' systems thinking I am hesitant to adopt the alternative conceptualization of 'structured' problems developed by Landry et al. (1985), who propose to see problems as 'structured' to the extent that the different actors in a human activity system subjectively perceive them as being identical (see also Van Groenendaal, 1989:101).

21. According to Winograd & Flores (1986:159-161) 'coordination systems' support operations such as: (a) the specification of the illocutionary origins of speech acts; (b) monitoring completion of certain conversations for action; (c) keeping track of temporal relations with a view of anticipating and coping with breakdowns; (d) the examination of the network; (e) automating recurrent interactions in the network; and (f) the facilitation of the generation of recurring propositional contents.

22. It can be argued, for example, that 'a method for the development of a specific information system' *inherently is* at the same time both 'a method for conveying changes in organizations and working-places' and 'a method for information policy and information planning'.

23. Vonk positions the term 'prototyping' against various other phrases with a procedural dimension that are used in the Information Management Studies discourse. In particular, he argues (1990:30-31) that prototyping is not to be confused with 'evolutionary development' (as for example Bemelmans, 1987:141-142 seems to do, CL) nor with 'end-user computing', 'incremental development' or 'participatory development'. According to Vonk, a prototyping approach is aimed at identifying 'real' requirements; when these are ultimately identified the prototyping process stops. In contrast, evolutionary development assumes that requirements will never stabilize; thus, evolutionary development is aimed at "a quick realization of successive versions of the production system itself" (Vonk, 1990:30), while prototyping is aimed at making such a system in the first place. Similarly, incremental development is primarily a modular or step by step development procedure, which is geared towards reducing the span between the definition of the system requirements and the actual installation of (parts of) the system. Although Vonk (1990:31) recognizes that incremental development combines well with prototyping, the aims are different and their is no inherent linkage between them. Furthermore, prototyping cannot be equated with participatory development since the definition of the former includes additional criteria (iteration, prototypes). Lastly, the term end-user computing refers to the "person or group that carries out the development", while prototyping points at "the way in which the development is carried out" (Vonk, 1990:31), which again means that there is no inherent connection between the two.

24. In order of decreasing 'operationality' on a strategic/operational dimension; in practice this results in a more or less chronological listing.

25. While the 'official' INSP process model for the production of potted plants (PTB, 1985) seems to be based on a management model in which strategic, tactical and operational management, implementation, control and reporting are crucial functions, Bots & Van Heck (1989) (departing from

the Wageningen Management Approach) identify goal/means management, means management, contribution management, work-stream management and implementation as the primary functions. Using their approach, they arrive at a very different process model for this sub-branch. Although Bots & van Heck do not extend their argument beyond process models, it is clear that distinguishing different processes has important repercussions for the identification of distinct information (sub)systems' (by means of clustering in C/U matrices), and for the data models that underlie the eventual systems produced.
An interesting observation is that neither of the two models described in the previous box include 'enterprise comparison' as a separate management activity. Nevertheless, when talking with growers of potted plants enterprise comparison emerges as an important and (in the eyes of growers) clearly distinct management activity. The same holds for other activities that growers themselves speak of; obviously this raises questions with regard to the compatibility of the management models applied by different groups of scientists and those of (different categories of) growers.

26. In a personal comment, Beers pointed out that the Standard Information Models for the different agricultural branches were based on different conceptual points of departure. Moreover, he commented that the end results cannot only be explained by the (different) philosophies adopted by the development teams, but also by the respective institutional backgrounds, areas of interest, motivations, convictions, etc., of the individual team members.

27. Although Beers disqualifies the scientific qualities of Standard Information Models, he argues that they may still be of practical relevance for the development of compatible information systems and the generation of a research agenda.

28. Alkemade (1990:7; 1991:14) refers to similar phenomena whereby INSP-LV-related efforts may obstruct rather than stimulate innovative activity. He refers to a respondent who claims that several existing initiatives which have later linked up with INSP-LV subsidies have bled to death due to efforts to obtain subsidies (i.e. meet the required criteria) and organizational overheads imposed on them. This in contrast to other innovations in the horticultural branch which have been quite successful without obtaining subsidies. Alkemade therefore concludes that INSP-LV-like subsidies are more suitable for larger projects which focus on the use and application of innovations, rather than on innovation itself.

29. In fact, a similar argument could be made in relation to newly emerging labels and abbreviations in relation to different categories and types of CT-development methods.

30. Except those implied by the reading of policy documents and evaluation reports, etc. by the researcher.

31. Winograd & Flores, following Heidegger, speak of 'blindness' (1986:97) (see also section 3.3).

32. There are some parallels between Luhmann's theory and my approach, for example, in that communication and its interpretative dimensions are central to both approaches, and that attention is paid to selection processes, recursive reproduction, etc. However, I am not at ease with some deterministic connotations and reified notions in his work. In fact, Luhmann seems to perceive actors as rather passive contributors to the (re)production of social systems. Social systems -in his view- are composed of communications (and not of actors) which somehow reproduce themselves more or less 'behind the back' of actors, even if it is the actors that communicate (1986:177-178). This conceptualization stems from Luhmann's rather rigid differentiation between 'psychic systems' (actors) and 'social systems' (e.g. organizations), whereby the two are only perceived as elements of each others environment (1984:346). In this view, the importance of agency in the (re)production of social

systems seems to be denied, which obviously runs counter to my theoretical approach. Thus, it is not surprising that when Schaap et al. base themselves on Luhmann's autopoiesis theory, this leads them to connect causally increasing self-referentiality with expanding societal differentiation and specialization (1990:263-264). This seems to be a rather functionalistic interpretation, which in fact runs counter to Maturana & Varela's original work, in which the idea of external determination is opposed, and replaced by a notion of internal determination (see section 3.3). In contrast to both 'externally' or 'internally' deterministic approaches, I prefer to perceive self-referential phenomena as inherently socially constructed. That is, these interpretative activities have political, normative and/or ideological dimensions, and involve the *active* and intentional construction of areas of knowledge and ignorance.

Chapter 8

Farming styles, extension and the use of DELAR
(case-study 1)

In this chapter, I will present the results of a case-study which explores empirically the consequences of diversity in farming for the use of a particular communication technology (DELAR) by farmers and extension workers. In section 8.1, I will introduce the nature of DELAR and its history, after which I will proceed to discuss both the reasons why I have selected it as a case-study and the research methodology that was adopted. Subsequently, I will in section 8.2 elaborate on how a classification into farming styles was arrived at in order to operationalize 'diversity' in the context of this study.

Then, a survey-based summary of differences in DELAR-use by farmers adhering to different styles will be presented in section 8.3, while a much more detailed and qualitative analysis of these differences can be found in section 8.4. I will show that meaningful differences in DELAR-use do indeed exist and that there are plausible connections between the specific ways of dealing with the CT, the different knowledge networks that farmers are part of, and the specific strategic notions that underlie the different farming styles. Also, some contradictions will emerge in relation to extension workers' evaluations of farms and farmers belonging to different styles. Following this, I will focus in more detail on the role that extension workers play in relation to DELAR in section 8.5.

Finally, I will discuss theoretical and practical implications of the study in section 8.6. In this section I will critically discuss: (a) common conceptualizations of the potential contribution of extension workers to improving CT-use by farmers; (b) the prospects of developing highly complex CT, and the importance of organizational arrangements for improving their learning potential; (c) the usefulness of the classification into styles of farming and more common approaches towards classification; and (d) my own effectiveness in contributing to social change.

8.1 Introduction, case-study selection and methodology

Before elaborating on case-study selection and methodology, I will first introduce the communication technology around which the case-study is centred (DELAR).

A brief introduction to DELAR and its history[1]

In the dairy branch, the post 1970 period can be characterized as a period of rapid scale enlargement and intensification (Van der Ploeg, 1987). As a result of large investments in housing facilities and equipment, the increased use of imported feed compounds, and other factors, farming practice became thoroughly reorganized. In this context, extension services and accountancy bureaus started to provide so called 'partial administrations' to farmers in order to monitor and evaluate the changes made. These administrations were 'partial' in that they did not include a full economic and/or fiscal bookkeeping, but provided feedback mainly on the technical and economic aspects of feeding and foddering practices. With the view of providing feedback and advice, extension workers and accountancy bureau staff engaged in a number of complex and time-consuming calculations, which were initially carried out manually. Around 1980, several cooperative accountancy bureaus and a regional public extension service (Consulentschap Rundveehouderij Arnhem; CRA) launched independent initiatives to automate such calculations. Although the Ministry had major reservations with regard to the initiative of its extension service[2], the latter managed to produce a CT at low development costs (fl. 2,300.-) in cooperation with the Agricultural University and two schools for higher agricultural education (in Deventer and in Velp). Not unlike the programs that simultaneously became available at cooperative accountancy bureaus, this first version only calculated a variety of result parameters (36) on the basis of data (102 variables) provided by farmers (Krabbenborg, 1982), and did not have an analytical dimension. However, CRA soon developed a close working relationship with a semi-state experimental station for cattle farming (Proefstation Rundveehouderij; PR) with the view of providing *norms* in relation to the parameters calculated; these norms were incorporated in the program in the course of 1982. Already in 1981, CRA, due to the growing numbers of participants, started to explore the possibility of contracting an accountancy bureau for doing the actual processing of the farmers' data, while CRA would remain responsible for acquisition, supervision, giving advice, etc. During the same period, PR took the initiative to further develop the partial administration into a national system. Thus, during the 1982-1984 period, complex negotiations took place between various regional extension services, PR and several accountancy bureaus. The end result was indeed that an almost national[3] partial administration was developed[4], which was labelled DELAR (DEeLAdministratie voor de Rundveehouderij; Partial Administration for Cattle Farming). This package was designed on the basis of several parts of previously existing automated administrations, and became the legal property of special societies erected by the accountancy bureaus[5]. PR became the coordinating body with respect to the contents of DELAR, while the public extension service remained involved in acquisition, supervision and providing advice.

At this point, the present procedure came in to being, which is that dairy farmers who want to participate in DELAR need to first register numerous data in a record-book. These data are then checked and entered into a central computer at the accountancy bureaus. After processing, the participants receive a print-out with overall results and analyses.

In the early days of DELAR, the public extension service was not only highly involved in giving advice on the basis of DELAR print-outs, but also in supervising the filling up of the record-book and organizational activities, which -from the farmers' perspective- made it still very much an extension service product. However, due to Ministerial pressures, budget cuts, and increasing participation in DELAR, it was decided in 1986 that the public extension service would have to limit itself to providing advice in relation to DELAR results. After a transition phase during the 1987/1988 period, the other activities were to be taken over by the accountancy bureaus. Also, the public extension service lost its virtual monopoly on providing advice in relation to DELAR results; from 1986 onwards it had to compete in this respect with the accountancy bureaus themselves, and the private extension services erected by the feed industries. In the light of these developments, the number of participants -which had steadily grown to 2,964 in 1986/1987 and 3,448 in 1987/1988- dropped again to about 2,700 in 1988/1989. By various sources this is attributed to the fact that DELAR was disconnected from the extension service, and to the disappointment and disinterest this has aroused among extension staff. It only added to the frustration of extension personnel that only *after* DELAR had been 'lost' to the private sector, the extension service itself was privatized in 1990. In this privatization process (see Bos, 1989) the responsibility for the contents of DELAR was transferred from the regional extension services and PR to the IKC-Veehouderij (Information and Knowledge Centre for Animal Farming). Also, the relationship between accountancy bureaus, DELAR and the new (partly) privatized extension service DLV (Dienst Landbouw Voorlichting; Service for Agricultural Extension) was renegotiated, amongst others with the view of preventing that DLV would start its own automated partial administration. These negotiations resulted in a renewed strengthening of the relationship between DELAR and the extension service. In 1990, participation in DELAR had risen again to 3,000.

The contents

In the record-book, farmers must register numerous technical and financial data which somehow relate to revenues and feed & fodder costs associated with dairy cattle and young (replacement) animals. Thus, data are included concerning, amongst others, land utilization, pasture management, the buying and selling of cattle, calving dates, milk production, milk revenues, fodder production, the buying and selling of feed and fodder, fertilization, etc. Although a considerable number of parameters and norms that DELAR calculates on the basis of these are of an economic nature, DELAR does not analyze overall economic performance, since important variables such as depreciation of assets, interest, redemption, and spending on contractors, veterinarians and family labour are not included. The calculation rules underlying the DELAR norms are based primarily on scientific insights and experimentation (e.g. Wieling et al., 1977).

Box 8.1: **Important parameters in DELAR for which norms are provided**

Below, a number of parameters are listed which are calculated in DELAR. For all these parameters DELAR norms are provided. All parameters are calculated over a period that starts at the first of May, and ends at the 30th of April of the next year.

(1) *turnover and accretion per milking cow*: referring to the buying and selling of cows, calves, yearlings, heifers, etc., and the natural replacement thereof;

(2) *feed costs per milking cow*: referring to the use of concentrates and milk products for cows and young cattle;

(3) *fodder costs per milking cow*: referring to costs/revenues related to the buying/selling of additional/superfluous roughage for cows and young cattle;

(4) *mowing percentage*: referring to the number of hectares mowed throughout the season, relative to the total number of hectares of pasture;

(5) *revenue minus feed & fodder costs per milking cow*: referring to total revenues -originating from milk, turnover and accretion, and hiring out pasture- minus feed and fodder costs as mentioned above;

(6) *revenue minus feed & fodder costs per hectare*: referring to total revenues -originating from milk, turnover and accretion, and hiring out pasture- minus feed and fodder costs as mentioned above;
(7) *total revenue minus feed & fodder costs*: referring to total revenues -originating from milk, turnover and accretion, and hiring out pasture- minus feed and fodder costs as mentioned above;
(8) *additional feed & fodder (expressed as kilo-VEM) per hectare of grazing land*: referring to the amount of feed and fodder (expressed as kilo-VEM, which is an indicator for energy available for milk production) that is additionally provided (through either buying or on-farm production) per hectare of grazing land;
(9) *concentrate consumption during the grazing period per milking cow*: referring to the kilograms of concentrates fed to milking cows and young cattle in the grazing (summer) period;
(10) *concentrate consumption during the stable period per milking cow*: referring to the kilograms of concentrates fed to milking cows and young cattle in the stable (winter) period;
(11) *feed & fodder costs per 100 kilograms of milk*: referring to total feed and fodder costs made for milking cows and young cattle;
(12) *costs on milk products for calves*: referring to the feeding of milk and/or milk replacing products to calves
(13) *expulsion percentage for milking cows*: referring to the number of cows that are expelled from the herd for a variety of reasons (related to a.o. low productivity, health, death, behaviour, over-completeness, etc.) relative to the total number of milking cows;
(14) *young cattle density*: referring to the number of young cattle (calves and yearlings) per 10 milking cows.
(15) *price per kilo-VEM of bought-in roughage*: referring to the price paid per energy unit for milk production which is acquired by means of buying roughage (see parameter 8).

For the calculation of DELAR norms, certain production circumstances and parameters (such as animal density per hectare, milk production per milking cow, fertilization, percentages fat and protein in milk, soil type, drainage and grazing system) are treated as given. The DELAR norm for concentrate consumption per milking cow in the grazing period, then, is to be understood as the concentrate consumption that -according to scientific insights- would have been appropriate, given animal density per hectare, milk production per cow, fertilization, etc. This way of calculating results in a certain degree of *farm-specificity* of the DELAR norms; i.e. the norms differ from farm to farm. Moreover, it is obvious that for those parameters and variables which are taken as starting point, no DELAR norms can be provided. Since some of these treated-as-given parameters are indeed variables that offer considerable scope for manipulation in the short and medium term, it is clear that DELAR is not an optimization program: i.e. it does not calculate an optimal application of means in order to achieve a specified goal within a particular context[6].

In practice, most participants receive a yearly print-out (a half-yearly print-out is optional) which encompasses numerous figures, such as: (a) a list of technical and economic parameters concerning the recently concluded (book)year (say 1986/1987); (b) the respective DELAR norms (if applicable); *and* (c) the deviations from these. For each parameter, (d) the result of the previous year (for this example 1985/1986) is presented as well. Finally, participants are provided with figures relating to other farms with the help of: (e) so-called comparative farm overviews, and (f) parameter comparisons. Comparative farm overviews consist of a selection of parameters and DELAR norms relating to several farms in the region, while parameter comparisons give an overview of the average results and norms for particular groups of farmers (for example classified according to the number of milking cows in the herd). In principle, farmers can refuse to be included in comparative overviews. If included, specific farms are only referred to by means of DELAR participant numbers; the corresponding names are not made public, so that a certain amount of privacy is guaranteed. In group meetings that are organized around DELAR results (e.g. in the context of study clubs), farmers can voluntarily lift anonymity and provide each other with their respective participant numbers.

In short, farmers have three basic opportunities for making comparisons with the help of the DELAR print-out: (1) with results concerning preceding years; (2) with DELAR norms; and (3) with other farms.

In the course of time, DELAR has been adapted, enlarged and rewritten several times. It is of relevance to note that at no stage in the development process dairy farmers were systematically involved. Depending on the options chosen[7], the costs for participation in DELAR amounted to between fl. 275.- and fl. 400.- for each farmer in the 1987/1988 period.

Selection of the case

This particular case-study was selected for various reasons. Some of these are of a pragmatic and/or methodological nature, while others relate to theoretical conceptions and practical issues referred to in chapter 5.

On the *pragmatic* side there was an invitation by some Wageningen friends and colleagues with whom I had cooperated before (Jan Douwe van der Ploeg and Dirk Roep) to participate in a study on strategic diversity in Dutch dairy farming. Van der Ploeg & Roep had already made contact with the regional public extension service in De Achterhoek, which had expressed its interest in the study, and was willing to cooperate and provide quantitative data (based on DELAR) about De Achterhoek farms in order to allow quantitative analysis. Thus, the research sample would be limited to DELAR participants, which obviously provided an opportunity to not only study diversity in relation to environmental and policy issues (as Van der Ploeg and Roep had initially intended) but also investigate its relation with the use of a CT like DELAR. The attractiveness of the research project was further enlarged by the fact that -even if external institutions cooperated- the study could be carried out in a highly independent manner; that is, without external interference regarding the problem statements, research questions, etc. In fact, with the privatization of the extension service in process, the research was to take place in some sort of an institutional vacuum. Moreover, DELAR is a CT which has from the outset been developed from an extension philosophy. Thus, focusing on DELAR might provide insight in a type of CT that -in terms of my classification of such technologies (see section 7.3)- is of special interest to extension scientists: Extension Worker Support*ing* Systems (rather than Extension Worker Support*ed* and/or Replacing Systems).

In *theoretical* terms, the whole idea of strategic diversity is of course related to the conceptualizations of human agency and structuration that I have adopted earlier on (see chapters 5 and 6). Given the centrality of knowledge in my conceptualization of structure, a case-study focusing on patterns of farming, and a 'knowledge intensive' technology such as DELAR seemed even more appropriate.

From a *methodological* point of view, carrying out a case-study on DELAR-use in De Achterhoek was attractive as well. In the present situation (see chapter 7), CT users are far from a representative category. DELAR is one of the most widely used (centrally operated) CT, and due to historical circumstances participation in De Achterhoek is particularly high[8]. Thus, although the situation in De Achterhoek is not representative for the Netherlands as a whole, I expected DELAR users in De Achterhoek to be as diverse a group of CT-using dairy farmers as one could find.

Most importantly, the prospective case-study fitted quite well with my *practical* concerns. In particular, the study was expected to contribute to the generation of the envisaged practical contributions 1, 2 and 3 (see chapter 2), amongst others by providing answers to the guiding questions that I have formulated in relation to these (see section 6.2).

Case-study methodology and sources

In this case-study I have used all research methods that were discussed in section 6.3. The issues that we focused on while using these methods, and the interconnections between them, need to be understood in the context of our aim, i.e. the generation of an empirically-based categorization of farmers. More so than in the case-studies that follow in chapter 10 and 11, I have in this case-study paid a great deal of attention to actors' general orientations, attitudes and evaluations, while less effort was spent in order to directly uncover concrete social practices. This contradicts in part with the methodological guideline that special attention should be paid to actors' day-to-day practices (see section 6.3). In fact, this phenomenon reflects the researchers' own learning process in that I came to fully recognize the importance of starting the analysis from social practices at a later stage in my research journey. However, in line with other methodological guidelines it was indeed attempted to ground my interpretation of actors' orientations, attitudes and evaluations in their own rationalizations and interpretations in relation to them, and place them in their relevant social context.

It must be noted that the design of research methods and procedures was a joint effort by Roep, Van der Ploeg and Leeuwis (see Roep et al., 1991). The procedure of constructing this categorization will be more integrally discussed in section 8.2. Below, I will chronologically discuss some details in relation to the methods and sources used.

First, a research area was selected within De Achterhoek. In order to ensure a certain degree of comparability between farm results, we decided to focus on five districts with sandy soils within De Achterhoek. The districts chosen are in fact the working areas of four extension workers who had expressed their willingness to cooperate.

Second, and in order to arrive at a selection of farms for extensive qualitative interviews, 28 farms were selected from the 142 DELAR users in the research area. To this end we have used the DELAR comparative farm overviews relating to the 142 farms for the 1986/1987 period. For practical reasons (the DELAR data had not been entered in a database yet), a manual procedure was followed in order to maximize diversity in terms of DELAR results among the selected farms. Farms were rank-ordered on seven key parameters which supposedly related to *intensity* and *scale*[9]. For each of these seven parameters, the six farms with the highest scores, and the six farms with the lowest scores were selected. Excluding duplication a total of 54 farms remained. In relation to these 54 farms, additional information (e.g. concerning labour input) was obtained by means of a small survey among the four extension workers. Then, the 54 farms were provisionally grouped into four broad categories[10]. Eventually, again catering for maximum diversity within the groups, seven farms were selected out of each category for the qualitative interviews.

Third, qualitative interviews were conducted with 27 of the 28 selected farmers in the summer of 1989. In most cases the interviews were held with the (mostly male) nominal 'head' of the enterprise, although in quite a few cases farmers' wives and/or children participated actively. The open interviews were conducted following a long list of themes, which were grouped under the headers of: (a) description of the present enterprise; (b) farm history; (c) practices concerning DELAR-use; (d) farming practices; (e) identification of regional types of farming; (f) attitudes and normative ideas in relation to farming; and (g) future prospects and development. The interviews were conducted by four different experienced interviewers (including the author), and lasted between two and four hours. An extensive report was written for each interview.

Fourth, on the basis of the qualitative interviews, a questionnaire was developed and pretested. Using this questionnaire, interviews were conducted in November 1989 (by the researchers and students in rural sociology) on 104 of the 142 farms[11]. Again, some of the interviews were more or less 'family' interviews. The questionnaire included 63 main questions, divided over the following themes: (a) brief impression of farm size and organization; (b) the impact of present and future policies (milk quotation, environmental and landscape and/or nature-conserving regulations) on the development of the farm; (c) future development directions and options; (d) self-classification on the basis of portraits; (e) assessment of present situation and future prospects; and (f) DELAR-use. The results of this survey were analyzed with the help of SPSSX, and linked with the available DELAR results in the 1986/1987 period. Since 104 (73%) out of 142 farms were interviewed, and generalization outside this population was neither intended, nor justifiable, I have used statistical methods solely for exploring potential differences between different categories of farmers within the sample.

Fifth, unstructured interviews were held with five extension workers. These interviews took place after participant observation in three group meetings for DELAR participants, and two discussions between extension workers and individual farmers.

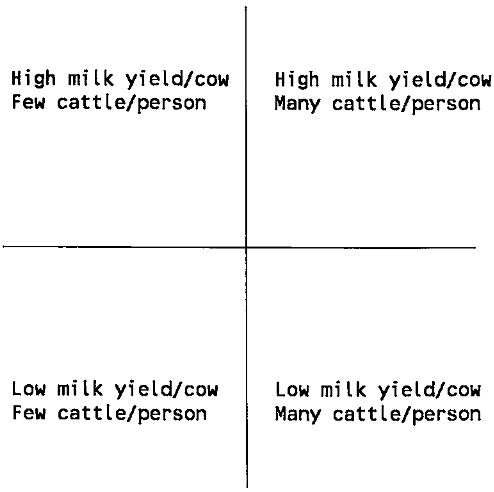
Sixth, three feedback sessions on the provisional research results were held with IKC-staff (1 meeting) and interviewed farmers (2 meetings).

8.2 Operationalizing diversity: 'self classification' into farming styles

In this section, I will discuss how we have arrived at the classification of farmers that I will refer to in my analysis of DELAR-use throughout the rest of this chapter. Our wish to generate a new classification of farmers was clearly connected with our critique of current classifications of farmers, which tend to be rooted in unilinear modes of thinking about agricultural development (see section 7.5). In contrast to earlier studies, in which diversity was still described in terms of an essentially researcher-defined classification (Bolhuis & Van der Ploeg, 1985; Leeuwis, 1989b), we have in this study tried to move into the direction of a farmer-generated classification. Thereby we have built upon, and extended, a methodology that had been developed by Van der Ploeg & Roep (1990). At this point, I will simply present the methodology (see also Roep et al., 1991); some problematic aspects and theoretical foundations will be touched upon in section 8.6.

First, in the qualitative round of interviews we have asked farmers to discuss different types of farms that they themselves distinguish. Based on earlier experiences, and in order to help them reflect on this issue, we introduced a scheme with two axes (again scale and intensity) and four descriptions in relation to these (see figure 8.1).

Figure 8.1: Scheme developed in order to generate discussion on different types of farms in the context of qualitative interviews

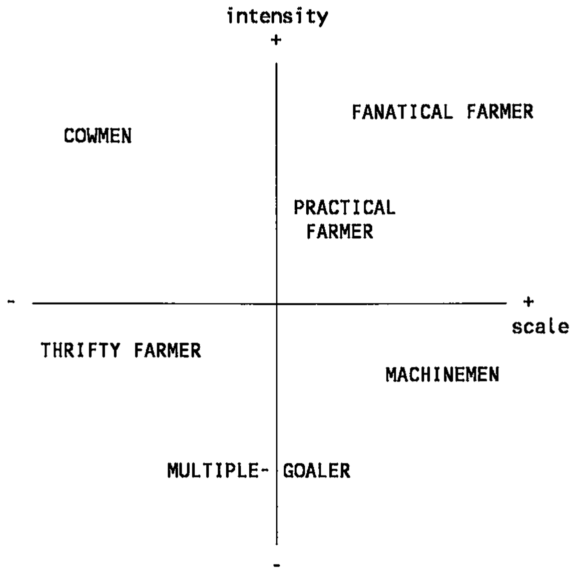


In relation to this scheme farmers were asked to elaborate on such questions as: (a) does this scheme bear relevance to your local context or not; (b) how would you label the different farms; (c) what types of farmers are associated with the scheme, and what goals do they pursue; (d) how do they work, and what are their results in terms of costs and revenues; (e) what are the future perspectives for different farms in the scheme; (f) which farms are most affected by present policies; (g) who works hardest, and who earns most; (h) where would you place your own farm in the scheme; (i) who is a 'good' farmer, and who is not, etc.

From the lively discussions that were evoked, the researchers were able to extract some frequently recurring descriptions and labels relating to different types of farmers. With the help of these we were able to construct the 'social map' presented in figure 8.2.

For every label, a short description was made on the basis of interview material (see box 8.2). These 'portraits' were presented and read to farmers during the survey (without mentioning the corresponding label) and farmers were asked to indicate the extent to which they could identify with it on a three point scale.

Figure 8.2: Social map of farmers on the basis of labels expressed by farmers in qualitative interviews (see also Roep et al., 1991:9)



Box 8.2: **Translated portraits presented and read to farmers during the survey**

Portrait 1 (relating to the Multiple Goaler)
I like a nice-looking, fat cow. Milk yield is not without importance; turnover and accretion, however, are very important indicators to me. They are the indicators that I attune my breeding to. By not letting the milk yields increase too much, I can keep more cows, and thereby increase turnover and accretion.

Portrait 2 (relating to the Thrifty Farmer)
I try to farm in as economical a way as possible. I reduce costs as much as possible, and I minimize indebtedness. In this manner, I manage to get a good income and maintain prospects for the future.

Portrait 3 (relating to the Practical Farmer)
In try to take very good care of everything I do. The art of running a farm is in fine-tuning. In developing one's farming enterprise one has to be careful not to shoot beyond the possibilities. One needs to find a practical balance.

Portrait 4 (relating to the Cowmen)
I very much enjoy breeding, and to me the sweet things in life are to take care of the animals, and see the milk flow. This is why I have to pay much attention to the production of roughage, and the fine-tuning of fodder and feed rations. In order to allow for this way of working I needn't have too many cattle, since that would be at the expense of individual care and attention.

Portrait 5 (relating to the Machinemen)
I most enjoy working with machinery, both on the land and in the garage while doing maintenance and repairs. The most important thing to me is to do the work on the land and in the stables as efficiently as possible. I do not aim at the highest milk production per cow; that is not much of a problem, for the masses will make up for it.

Portrait 6 (relating to the Fanatical Farmer)
In order to have a good income, one needs to first invest firmly, and spend a lot of money. It means that one has to work hard and really push it. That is why they sometimes call me a fanatic; but one has to be like that if one wishes to survive.

Table 8.1: The extent to which respondents identify with the different portraits (n=104)

1. with Portrait 1 (Multiple Goaler) I can	
not identify	47%
partly identify	45%
fully identify	8%
2. with Portrait 2 (Thrifty Farmer) I can	
not identify	36%
partly identify	45%
fully identify	19%
3. with Portrait 3 (Practical Farmer) I can	
not identify	5%
partly identify	41%
fully identify	54%
4. with Portrait 4 (Cowmen) I can	
not identify	5%
partly identify	55%
fully identify	40%
5. with Portrait 5 (Machinemen) I can	
not identify	55%
partly identify	39%
fully identify	6%
6. with Portrait 1 (Fanatical Farmer) I can	
not identify	20%
partly identify	55%
fully identify	25%
7. I identify most with	
Portrait 1 (Multiple Goaler)	5%
Portrait 2 (Thrifty Farmer)	9%
Portrait 3 (Practical Farmer)	38%
Portrait 4 (Cowmen)	30%
Portrait 5 (Machinemen)	4%
Portrait 6 (Fanatical Farmer)	12%
a combination of portraits	4%

The extent to which farmers identified with the portraits is summarized in table 8.1. We could have treated the responses to the last question (nr. 7 in table 8.1) as the final classification of DELAR participants. However, we were slightly unhappy with the classification for a variety of reasons. First, using only the last question did not do justice to the more refined information provided by the answering of the previous 6 questions. Thus, using only the last question would mean a loss of subtlety, and an exclusion of the possibility to take (non)identification with other types of farmers into account. Second, when conducting the interviews we had the impression that farmers themselves did not always fully recall all the portraits at the time of answering the last question. Third, the distribution over the different categories on the basis of the seventh question would be very uneven (in fact more uneven than we expected on the basis of the qualitative interviews), which complicated the drawing of conclusions with a reasonable degree of plausibility. In particular, we had the feeling that portrait 4 (Practical Farmer) had been too vague and/or too generally appealing, so that the original group of Practical Farmers still included quite a variety of farmers.

On the basis of these considerations, we decided to search for a statistical technique that could help to refine the assignment of farmers to the different categories, while taking into account all seven questions mentioned in table 8.1. Eventually, we found a suitable technique in discriminant analysis.

Discriminant analysis is a multi-variate technique by means of which it is possible to analyze the extent to which variables that are expected to discriminate between the groups of a given classification, do actually discriminate. In the procedure, discriminant functions are generated which can be interpreted as dimensions along which groups in the classification discriminate. In principle, it is possible to use the discriminant functions in order to classify *new* cases with unknown membership with a certain probability (provided of course that their score on the discriminating variables is known).

In our case, we have treated the classification on the basis of the seventh question as the 'given classification', while we have treated the answers to the preceding 6 questions as the 'discriminating variables'[12]. Carrying out a direct (as opposed to stepwise[13]) discriminant analysis, three significant discriminant functions (at $\alpha = 0.05$) were identified, which together explain almost 89 percent of the variance (see table 8.2).

Table 8.2: Relative importance and significance of the 3 discriminant functions that remained in the analysis

function	eigenvalue	% of variance explained	cumulative %	after deriving of function	Wilks' lambda	corresponding chi-square	significance
				0	0.233	135.60	0.0000
1	0.632	35.21	35.21	1	0.380	90.08	0.0000
2	0.581	32.41	67.61	2	0.600	47.46	0.0000
3	0.375	20.92	88.53	3	0.826	17.82	0.0067

The contribution of the discriminating variables (i.e. the identification of farmers with the 6 portraits) to the discriminant functions is expressed in table 8.3. The discriminant function coefficients in this table can be interpreted analogous to the interpretation of beta weights in multiple regression analysis. In order to facilitate interpretation, the portraits from table 8.1 have been reshuffled in such a way that the highest positive and negative coefficients for each function are brought together.

Table 8.3: The contribution of the discriminating variables to the discriminant functions, expressed in terms of standardized discriminant function coefficients.

identification with		function 1	function 2	function 3
Fanatical Farmer	(portrait 6)	**0.70716**	0.37981	-0.23015
Thrifty Farmer	(portrait 2)	**-0.46025**	0.41126	-0.09722
Machinemen	(portrait 5)	0.20387	**0.77229**	0.22662
Cowmen	(portrait 4)	0.38356	**-0.52070**	0.71427
Multiple Goaler	(portrait 1)	-0.25595	0.05839	**0.73599**
Practical Farmer	(portrait 3)	-0.27065	-0.34107	**-0.60012**

For the interpretation of the discriminant functions (see also Roep et al., 1991:33-35)[14], it is worthwhile to note that on the first function the Fanatical Farmer seems to be the polar-opposite of the Thrifty Farmer (and to a somewhat lesser extent the Multiple Goaler). Interestingly, this seems to correspond quite well with the social map that was drawn on the basis of qualitative interviews (see figure 8.2). On the basis of the portraits, we propose that the first dimension might be interpreted as being related to diverging convictions in relation to making investments and the spending and/or borrowing of money (i.e. the readiness to make large investments if necessary with borrowed money, versus the wish to minimize investments and indebtedness). On the second function Machinemen and Cowmen are each others polar-opposites, which again compares well with figure 8.2. This dimension, then, seems to be related to different working priorities and philosophies (i.e. a roughish way of working going along with large scale mass-production, versus a high degree of individual animal care and fine-tuning on a smaller scale). Although still significant, the third function is difficult to interpret at this point. As I will argue later on, this dimension may reflect an orientation towards technical versus economic parameters, norms and issues (see table 8.15).

From this point onwards, it becomes most visible that we have used the discriminant analysis in a way that deviates from common practice. While the discriminant functions are utilized commonly to classify new cases with unknown membership, we have used it for reclassifying the original population on which the functions themselves are based. For reasons mentioned above, we do in fact consider the new classification to be superior to the original one. The refined classification is provided in table 8.4, while table 8.5 gives an overview of the origins and destinations of the reclassified cases.

As can be noticed from table 8.5, the discriminant analysis has helped us to reclassify a considerable number (52) of farmers. In terms of absolute numbers -and as we had hoped-mainly original Practical Farmers (24) were redistributed, so that presumably the new group became more specific. Percentage-wise many original Thrifty Farmers were redistributed as well, and they were replaced mainly by original Practical Farmers; presumably those who - apart from identifying with portrait 2 (Thrifty Farmer)- identified least with portrait 6 (Fanatical Farmer).

Table 8.4: Number of cases per group in original classification, and in refined classification.

portrait	original	refined
Multiple Goaler (MG)	5	10
Thrifty Farmer (TF)	9	13
Practical Farmer (PF)	39	24
Cowmen (CM)	31	34
Machinemen (MM)	4	7
Fanatical Farmer (FF)	12	16
combination (ungrouped)	4	0
TOTAL	104	104

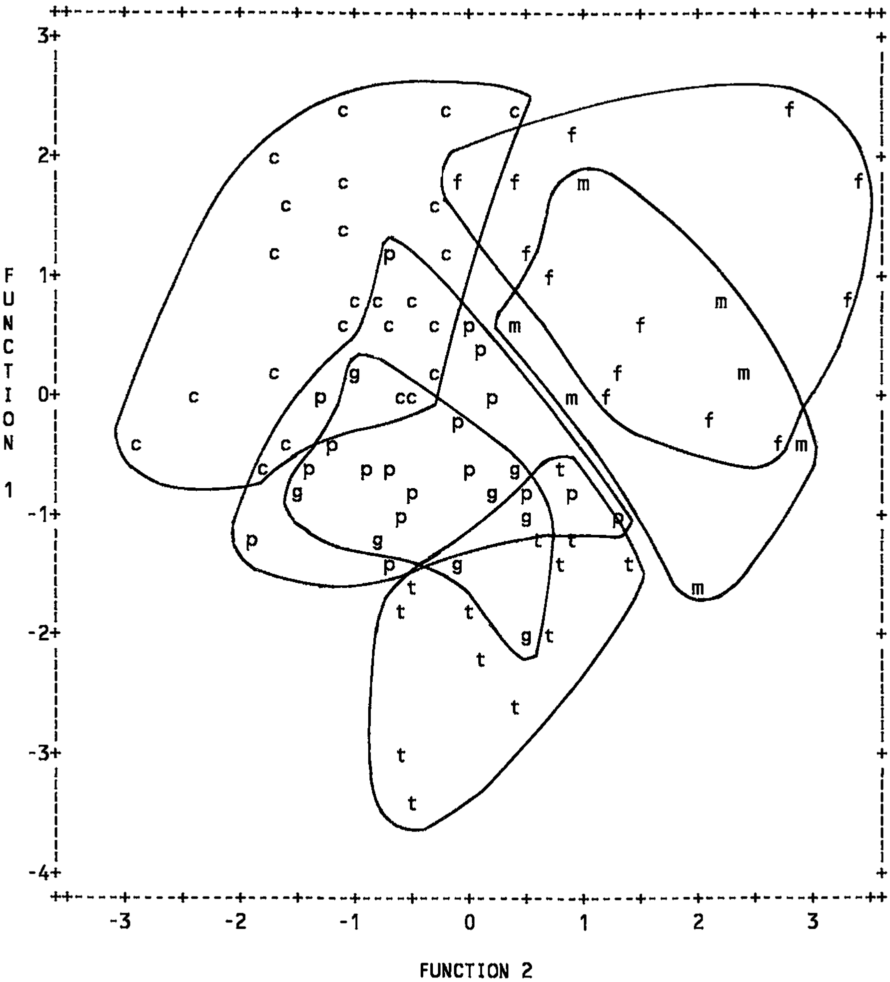
Table 8.5: Destinations and origins of re-classified cases.

	MG (old)	TF (old)	PF (old)	CM (old)	MM (old)	FF (old)	comb. (old)	TOTAL (refined)
MG (refined)	3	3	2	2				10
TF (refined)	1	2	8		1		1	13
PF (refined)		3	15	3		1	2	24
CM (refined)			9	22	1	1	1	34
MM (refined)	1	1		1	2	2		7
FF (refined)			5	3		8		16
TOTAL (old)	5	9	39	31	4	12		104
% unchanged	60%	22%	39%	71%	50%	67%	total unchanged %	50%

A visual representation of the distribution of the new classification in the space of the two first discriminant functions is provided in figure 8.3.

In Roep et al. (1991) (and also Roep & Roex, 1992) it is shown extensively that -in terms of our new classification- the different categories of farmers are indeed characterized by, amongst others: (a) quantitative differences in scale and intensity that in many ways correspond with the visual representation in figure 8.2; (b) different patterns of both input

Figure 8.3: Distribution of the new classification in the space of the two first discriminant functions (see also Roep et al., 1991:35).



g: Multiple Goaler
c: Cowmen
t: Thrifty Farmer
m: Machinemen
p: Practical Farmer
f: Fanatical Farmer

(Note that -due to doubles- the number of cases listed in the figure does not for each category correspond exactly with the actual number of cases according to the new classification.)

and output (in the technical sense), and costs and revenues (in the economic sense); (c) different farming practices; (d) different models of reasoning about the farm; (e) different development histories and prospective directions for future development; and (f) different attitudes and strategies vis-à-vis governmental policies of various kinds. Within each category these differences form a meaningful and rather coherent pattern, which -according to Roep et al. (1991:2-3)- is carefully and strategically coordinated on the basis of farmers' conceptions of how one *ought to* run a farm. Such patterns of farming, then, are labelled *'farming styles'* or *'styles of farming'*. This term is derived from Hofstee (1985) who -in contrast to Roep et al. (1991)- uses the term to refer to inter-regional cultural style differences, rather than to intra-regional diversity (see section 5.1 for a closer definition and theoretical positioning of the term).

In the context of this book I cannot elaborate in detail on the patterns referred to above. Although I will certainly touch on several elements in this respect, the remainder of this chapter will focus on the relation between farming styles and the use of DELAR by farmers and extension workers.

8.3 A quantitative bird's-eye view of differences in DELAR-use by farmers

This section will start with a brief analysis (on the basis of the survey material) of the importance that farmers belonging to different styles assign to different sources of knowledge and information. In doing so, I will focus especially on the relation between the different styles of farming and extension. For this particular purpose I do not only base myself on the survey held among 104 farmers, but also on the small survey which was (in the context of the selection procedure, see section 8.1) held among four extension workers in order to get additional information on farms. In relation to this latter survey, I will only use the data concerning 42 farms, i.e. those farms that were included in the main survey as well. Subsequently, I will give a summary of differences in DELAR-use by farmers as it emerges from the survey. Both exercises are meant mainly to provide background for the more qualitative elaborations on the different styles provided in section 8.4.

In this chapter, I will refer to the different farming styles by using the labels introduced in section 8.2. Thereby I will use capitals (as in 'Fanatical Farmer') when I refer to these farmers in an ideal-typical manner, while we will use lower-case letters (as in 'fanatical farmers') when I refer to quantitative figures in relation to the category of farmers mentioned.

Farming styles, sources of knowledge and information and the view of extension workers

There are indications that farmers belonging to different styles, in interaction with their environment, structure their 'knowledge network' in systematically different ways[15]. It appears from table 8.6, for example, that practical farmers and fanatical farmers are in most frequent contact with public extension workers, which indicates that either they themselves tend to seek this contact, or that extension workers are keen to keep in contact with these larger-scale and more intensive enterprises (as I will show later on, the former seems to be more plausible in the case of the Practical Farmer, while the latter seems to apply more in case of the Fanatical Farmer).

Table 8.6: Different styles of farming and the frequency of contact with public extension workers, as reported by extension workers in relation to 41 farmers (1 missing value).

	mean
multiple goalers (n=4)	2.5
thrifty farmers (n=5)	2.6
practical farmers (n=7)	3.5
cowmen (n=16)	3.1
machinemen (n=4)	2.8
fanatical farmers (n=5)	3.4
$F = 3.71$ $p = 0.008$ Pairs of groups which differ at $\alpha = 0.05$	MG vs FF;PF TF vs FF;PF

The frequency of contact was measured on a four point scale (1 = never; 2 = occasionally; 3 = regularly; 4 = often). An analysis of variance test, comparing the means of the 'dependent' variable for the categorization variable, was carried out[16]. A DUNCAN procedure[17] was used in order to identify pairs of groups that have significantly different means at the $\alpha = 0.05$ level.

In relation to the 'dependent' variables presented in tables 8.7, 8.8, 8.9, 8.10, and 8.13, similar tests were carried out. I am aware that in this table (and also in the tables 8.8, 8.9 and 8.10) the numbers of cases per cell are for some categories lower than is required for the analyses carried out. Nevertheless, I have decided to conduct such analyses for exploratory purposes, even if under these circumstances the likelihood of finding statistically significant differences is limited. In some cases, however, the sociological significance of the differences may be higher than the statistical significance.

The contacts with the public extension service cannot be looked at in isolation. It seems that in each style different emphases are made in relation to the relative importance of different sources for acquiring new ideas and information (see table 8.7). At first sight, one gets the impression that -at least in terms of the sources mentioned- machinemen and (to a lesser extent) multiple goalers are in a somewhat 'isolated' position.

The survey also included two questions which related to the knowledge and information issue at a higher level of abstraction. In order to 'measure' the farmers' orientation towards the market and towards technology, farmers were asked to choose one of two alternatives that in their view was the most decisive for the future of the farm. Along the 'orientation towards the market' dimension farmers were asked to indicate their view on whether 'taking care of cattle and pasture to perfection' or 'optimally adjusting to developments in the market' would be most important. It appeared that machinemen, multiple goalers, thrifty farmers and cowmen clearly opt for the first alternative, while practical farmers and fanatical farmers are considerably more inclined towards the second option.

Table 8.7: The importance of different sources for acquiring new ideas and information (n=104).

	multiple goalers	thrifty farmers	practical farmers	cowmen	machine-men	fanatical farmers	F, p, and pairs wh. diff. at α = 0.05
farmer magazines	— 2.9	0 3.1	0 3.1	+ 3.2	0 3.0	++ 3.3	F = 0.62 p = 0.69
public extension	— 2.7	0 2.9	0 3.0	0 2.9	+/— 2.9	— 2.7	F = 0.54 p = 0.74
study clubs	— 2.2	0 2.4	0 2.3	0 2.5	+ 2.6	+ 2.6	F = 0.45 p = 0.81
private extension	0 2.5	+ 2.6	+ 2.6	0 2.4	—— 1.4	— 2.3	F = 3.66 p = 0.005 MM vs All
DELAR meetings	0 2.4	+ 2.6	0 2.4	+/— 2.4	—— 2.0	+ 2.6	F = 0.67 p = 0.65
specialists	— 2.4	—— 2.2	+ 2.8	+ 2.8	— 2.4	0 2.6	F = 1.76 p = 0.13 TF vs CM;PF
breeding society	++ 3.1	+ 2.8	0 2.6	0 2.6	— 2.3	+ 2.9	F = 1.12 p = 0.36
colleagues	+ 3.0	— 2.7	0 2.9	+ 3.0	— 2.6	+ 3.1	F = 0.84 p = 0.52

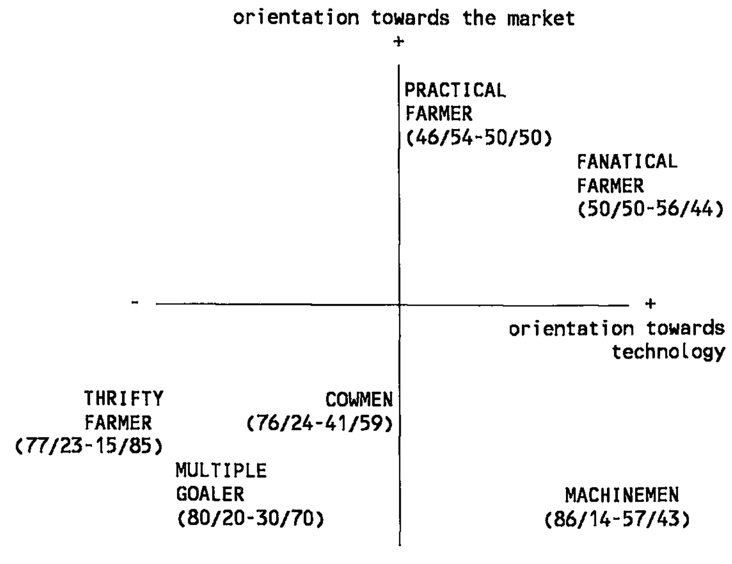
The importance of different sources was measured on a four point scale (1 = unimportant or not applicable due to non-participation; 2 = is sometimes useful; 3 = important; 4 = indispensable).

In the cells the group means are given. In table 8.7, as well as in four other tables in this section, I also make use of indicators such as ++, ——, 0, — and +. These indicators refer to the *relative* importance or evaluation in comparison with those in other styles. Thus, they are no absolute measure for importance or evaluation expressed by farmers within a style. For example, the '—' at the intersection between 'multiple goalers' and 'farmer magazines' does not imply that multiple goalers find these magazines unimportant (in fact the mean value of 2.9 indicates that, on average, they find them important), but only that *-in comparison with other styles-* they tend to find them less important. In some cases the assignment of a specific indicator is indeed somewhat arbitrary. Moreover, I use the indicators even when the differences are not statistically significant. Nevertheless, since the indicators help indeed to get quick overviews, and because the differences may have a sociological (rather than a statistical) significance (see section 6.3), I have chosen to use them anyway.

— = relatively less important in comparison with other styles
—— = relatively much less important in comparison with other styles
\+ = relatively important in comparison with other styles
++ = relatively much more important in comparison with other styles
+/— = relatively strong dispersion in comparison with other styles (standard deviation > 0.95)
0 = average in comparison with other styles

Along the 'orientation towards technology' dimension farmers were asked to indicate the decisiveness of 'keeping up to date with the newest knowledge and technologies, and translating these towards my own situation' versus 'taking care continuously in order to have grip on the farm, and applying techniques on the basis of my own insight and experience in order to improve'. Machinemen and fanatical farmers seemed to value the first description most, while thrifty farmers and multiple goalers clearly express their preference for the second. Practical farmers seem to lean towards the fanatical farmers in this respect, while cowmen seem to be relatively neutral. The foregoing is summarized in figure 8.4.

Figure 8.4: Relative orientations towards the market and technology for the different farming styles (n=104) (see also Roep et al., 1991:40).



The numbers indicate subsequently the percentage of farmers who chose for the first/second option on the 'market' dimension, and the percentage of farmers who chose for the first/second option on the 'technology' dimension, within each style of farming (see the text for the order of options).

As mentioned before, the relationship between extension workers and farmers needs to be understood in terms of the interaction between the two. This is for instance exemplified in the judgements that extension workers make in relation to the different farms. These judgements are summarized in table 8.8, from which it clearly emerges that specific styles may be systematically evaluated in a relatively positive or a relatively negative manner.

It is striking to see that the degree of contact with extension workers (table 8.6) and the latter's evaluation of the farm organization and set-up seem not only to correlate positively with each other, but also with increasing intensity and scale (see figure 8.2, and Roep et al. 1991). Those styles that operate on a larger scale and with a higher intensity (fanatical farmers and practical farmers), tend to be evaluated in a relatively positive fashion, while the opposite holds for the smaller scale and lower intensity farms (multiple goalers and thrifty farmers). While apparently the smaller scale of the cowmen is more than compensated with their high levels of intensity, the larger scale associated with machinemen does not seem to make up for their low intensity. This indicates that intensity may be more important to extension workers for evaluating efficiency, than scale. The same pattern emerges from table 8.9, which summarizes the extension workers' evaluation of the personal qualities of farmers belonging to different styles.

Table 8.8: The evaluation of several aspects of farm organization and set-up by extension workers for each style of farming (n=42).

	multiple goalers (n=4)	thrifty farmers (n=5)	practical farmers (n=8)	cow-men (n=16)	machine-men (n=4)	fanatical farmers (n=5)	F, p, and pairs which differ at α = 0.05
efficiency of stables for cows	—— 2.8	— 3.6	+ 3.8	0 3.7	+ 3.8	++ 4.0	F = 0.86 p = 0.52
efficiency farm buildings	—— 2.3	— 3.4	0 3.6	0 3.6	— 3.3	++ 3.8	F = 1.58 p = 0.19 MG vs PF;CM;FF
efficiency of machinery	—— 3.3	— 3.6	+ 4.0	++ 4.1	— 3.8	+ 4.0	F = 1.27 p = 0.30
efficiency of pasture	—— 3.3	0 3.8	0 3.9	+ 4.0	+ 4.0	++ 4.2	F = 0.98 p = 0.45
balance in organization	—— 3.3	+ 4.0	—/+ 3.6	+ 3.9	—— 3.3	++ 4.2	F = 1.35 p = 0.27
Overall scale variable	—— 3.0	0 3.7	0 3.7	+ 3.9	0 3.6	++ 4.0	F = 1.57 p = 0.19 MG vs CM;FF

The evaluation of each aspect was measured on a five point scale (1 = bad; 2 = mediocre; 3 = reasonable; 4 = good; 5 = optimal). The last variable in the table is a scale variable which is calculated as the sum of the previous five efficiency/balance variables divided by five. Cronbach's α of this variable is 0.86; hence, the scale is sufficiently reliable (after elimination of the 'efficiency of pasture variable' Cronbach's α would be 0.87; elimination of all other variables would result in a lower Cronbach's α).
In the cells the group means are given. I also use the indicators that were introduced in relation to table 8.7.

— = relatively less favourable in comparison with other styles
—— = relatively much less favourable in comparison with other styles
\+ = relatively favourable in comparison with other styles
++ = relatively much more favourable in comparison with other styles
+/— = relatively strong dispersion in comparison with other styles (standard deviation > 1)
0 = average in comparison with other styles

Table 8.9: The extension workers' evaluation of personal qualities of farmers belonging to different styles (n=42).

	multiple goalers (n=4)	thrifty farmers (n=5)	practical farmers (n=8)	cow-men (n=16)	machine-men (n=4)	fanatical farmers (n=5)	F, p, and pairs which differ at α = 0.05
crafts-manship	—— 2.8	0 3.8	+ 4.0	+ 4.0	—/+ 3.3	++ 4.2	F = 2.78 p = 0.032 MG vs TF;PF; CM;FF
entrepre-neurship	— 3.0	+ 4.0	++ 4.1	++ 4.1	—— 2.8	+ 3.8	F = 3.14 p = 0.019 MM vs TF;PF;CM MG vs PF;CM
manage-ment qualities	—— 2.8	+ 3.8	++ 3.9	—/+ 3.6	—— 2.8	++ 4.0	F = 1.83 p = 0.13

The evaluation of each personal quality was measured on a five point scale (1 = insufficient; 2 = mediocre; 3 = reasonable; 4 = good; 5 = outstanding). In the cells the group means are given. I also use the indicators that were introduced in relation to table 8.7 (see table 8.8 for the appropriate index).

Table 8.10: Future prospects for farms belonging to different styles of farming as perceived by extension workers (n=41, 1 missing value).

	mean
multiple goalers (n=4)	2.8
thrifty farmers (n=5)	3.6
practical farmers (n=7)	4.1
cowmen (n=16)	3.8
machinemen (n=4)	3.8
fanatical farmers (n=5)	4.4
F = 2.40 p = 0.056 Pairs of groups which differ at α = 0.05	MG vs CM;PF;FF

The perceived future prospects were measured on a five point scale (1 = bad; 2 = mediocre; 3 = reasonable; 4 = good; 5 = outstanding).

Not surprisingly, this pattern coincides with the extension workers' evaluation of the future prospects of the different farms (see table 8.10). It is especially those farms that have developed a large scale of operation and a high degree of intensity (i.e. fanatical farmers and practical farmers) that are thought to have relatively 'outstanding' future prospects. Roughly speaking, the prospects for the cowmen and the machinemen are considered to be 'good', while those for the thrifty farmers are 'reasonable' to 'good'. The multiple goalers are again evaluated most negatively in this respect.

The use of DELAR

From table 8.11 it emerges that there may be differences with regard to the original reasons for participating in DELAR. Machinemen particularly emphasize the importance of getting an overview of the farm, while for fanatical farmers and thrifty farmers the expectation that results could be improved seems to be most significant. Multiple goalers, practical farmers and cowmen mention both reasons. A further point of attention is that thrifty farmers and multiple goalers relatively frequently refer to the advice of extension workers as an important reason for participation. Similarly, practical farmers, machinemen and thrifty farmers mention 'other' grounds, which appeared to relate mainly to opportunities to compare with other farms.

Table 8.11: The percentage of farmers per farming style who retrospectively designate particular reasons and/or expectations as important in guiding their original decision to become DELAR participant.

	multiple goalers (n=10)	thrifty farmers (n=13)	practical farmers (n=24)	cow-men (n=34)	machine-men (n=7)	fanatical farmers (n=16)	Chi-square and p
extension worker advice	40%	38%	21%	18%	14%	25%	Chi = 4.14 p = 0.53
improve enterprise results	50%	85%	50%	71%	29%	75%	Chi = 10.50 p = 0.06
get overview of important parameters	60%	31%	54%	53%	71%	38%	Chi = 4.89 p = 0.43
follow results from year to year	30%	15%	21%	35%	43%	13%	Chi = 5.26 p = 0.39
discern costs for pigs and cattle	10%	0%	8%	6%	0%	6%	Chi = 1.85 p = 0.87
other reasons	10%	23%	21%	3%	29%	13%	Chi = 6.87 p = 0.23

In relation to this table (and also table 8.12), Chi-square tests of statistical significance, comparing the frequencies of the six 'dependent' variables for the categorization variable, were carried out.

Table 8.12: The percentage of 1986/1987 DELAR participants who had stopped in 1989 (n=104).

	% stopped
multiple goalers	40%
thrifty farmers	38%
practical farmers	17%
cowmen	24%
machinemen	29%
fanatical farmers	31%
TOTAL	27%
Chi-square = 3.39	p = 0.63

A relatively large number of 1986/1987 DELAR participants had stopped using DELAR in 1989 (see table 8.12). The comparatively high percentage of 'drop-outs' among thrifty farmers and multiple goalers may in part be related to their relatively 'external' motivation for participation (i.e. the extension worker advice). However, the most important reason for discontinuing participation is quite generally that, after a few years, DELAR does not help to generate new insights any more, and that it (therefore) requires too much investment in terms of time. As I will show in section 8.4, it is indeed plausible that such objections are more valid for thrifty farmers and multiple goalers, and less valid for practical farmers (of which only 17% had discontinued participation). Complexity, disagreement with DELAR norms, increasing costs and little practical relevance were also sometimes mentioned in order to explain discontinuation. A change-over to an on-farm 'integral' MSS on a personal computer was mentioned especially by fanatical farmers.

It appears that, in relative terms, the interest in the different opportunities for comparison offered by DELAR varies from style to style, even if within each style of farming (except for the practical farmers) the comparison with DELAR norms is deemed the most interesting opportunity (see table 8.13).

The fanatical farmers seem to have a relatively strong preference for comparing their own results with norms, while practical farmers and part of the multiple goalers find this type of comparison less interesting. Instead, multiple goalers, practical farmers and also cowmen are more interested than others in comparing their results with their results in previous years, i.e. they are more inclined to take their own farm as a point of reference. Thrifty farmers, machinemen and part of the practical farmers -in comparison with other styles- tend to find comparisons with other farms more interesting. Thereby it must be noted that thrifty farmers and machinemen do not particularly value their colleagues as important sources of information (see table 8.7). Similarly, it emerges from the survey that thrifty farmers -in sharp contrast to others and especially multiple goalers- know relatively few DELAR participant numbers. Hence, they seem to only compare in relatively anonymous ways; that is, without having access to detailed context information.

Table 8.13: The interest that farmers belonging to different styles expressed in relation to various opportunities for comparison offered by DELAR, relative to the interests expressed in other styles (n=104).

	multiple goalers (n=10)	thrifty farmers (n=13)	practical farmers (n=24)	cow-men (n=34)	machine-men (n=7)	fanatical farmers (n=16)	F, p, and pairs which differ at α = 0.05
comparing with previous years	+ 2.0	— 2.4	+ 1.8	+ 1.8	—— 2.7	0 2.2	F = 3.23 p = 0.010 CM vs TF;MM PF vs TF;MM
comparing with other farms	0 2.2	+ 2.0	—/+ 2.3	—— 2.6	+ 2.0	—— 2.6	F = 2.25 p = 0.056 TF vs CM;FF
comp. with DELAR norms	—/+ 1.8	0 1.6	— 1.9	0 1.6	+ 1.3	++ 1.2	F = 1.87 p = 0.11 FF vs PF

Respondents were asked to rank-order the different types of comparison in order of their interest in them (1 = first choice; 2 = second choice; 3 = third choice). In the cells the group means are given. I also use the indicators that were introduced in relation to table 8.7.

—	= relatively less interesting in comparison with other styles
——	= relatively much less interesting in comparison with other styles
+	= relatively interesting in comparison with other styles
++	= relatively much more interesting in comparison with other styles
+/—	= relatively strong dispersion in comparison with other styles (standard deviation > 0.9)
0	= average in comparison with other styles

From the above, it emerges that there may be qualitative differences in the way farmers belonging to different styles compare with others (for further elaboration see sections 8.4 and 8.5). One aspect of these qualitative differences is summarized in table 8.14, which indicates the priorities that farmers belonging to different styles have when it comes to comparing with others.

Table 8.14: Different forms of comparing with other farms and their respective priority for each farming style. (The percentage of farmers within each style indicating that a particular type of comparison is 'most valuable' is provided between brackets; n=104.)

	forms of comparing with other farms, in order of decreasing priority
multiple goalers	- with averages of a specific group, selected by size and 'type' (40%) - with overall average of DELAR participants (30%)
thrifty farmers	- with averages of a specific group, selected by size and a variety of input and output parameters (38%) - with overall average of DELAR participants (31%) - farms with remarkably good results (31%)
practical farmers	- with averages of a specific group, selected by size and 'type' (54%) - with farms that I am well acquainted with (17%) - farms with remarkably good results (17%)
cowmen	- with averages of a specific group, selected by size, stocking density, breed of cattle and milk yield per cow (53%) - farms with remarkably good results (21%)
machinemen	- with averages of a specific group (not enough data to identify common selection criteria) (43%) - farms with remarkably good results (29%) - with farms that I am well acquainted with (29%)
fanatical farmers	- with farms that I am well acquainted with (38%) - farms with remarkably good results (25%) - with averages of a specific group (not enough data to identify common selection criteria) (19%)

Attitudes and position vis-à-vis DELAR norms

The majority of farmers within each style -and especially multiple goalers and fanatical farmers- indicate that they use DELAR parameters and norms in order to set goals for the next year. Between the different styles, however, different emphases are made concerning: (a) the *importance* of particular parameters and norms; (b) the *desired result* vis-à-vis specific norms (either at the norm, above the norm, or below the norm); and (c) the *types* of norms and parameters that are considered important. In relation to this latter variation, a distinction can be made between the more *technical* and the more *economic* parameters and norms. By 'technical' parameters and norms, I infer those that (even if they may be expressed in terms of money) are a direct expression of concrete farming practices (e.g. mowing percentage, feed costs per milking cow, young cattle density, etc.). More 'economic' parameters and norms (e.g. revenue minus feed & fodder costs per hectare) can be less directly translated into concrete practices. In table 8.15, I have summarized the essence of the strategies connected with each style of farming, and the types of parameters and norms that are considered important.

Table 8.15: Farming styles, the essence of the strategies that are related to them, and the types of parameters and norms that are considered to be important.

	essence of strategy	types of parameters and norms that are deemed relatively important
Multiple Goaler	self-sufficiency through low external input	technical
Thrifty Farmer	monetary balance	economic
Practical Farmer	practical balance, especially in labour organization	economic
Cowmen	reaching a high milk yield per cow through labour-intensive practices	technical (especially those related to feed costs)
Machinemen	mass production through labour-extensive practices	technical
Fanatical Farmer	gaining a competitive advantage over others	economic

The essence of each strategy has been derived primarily from the qualitative interviews. The characterization of the types of parameters and norms that are deemed important are derived from the survey in combination with qualitative material. In the survey, farmers were asked to indicate the importance of all parameters mentioned in box 8.1 in section 8.1. Of these parameters, the numbers 1,3,5,6,7,8 and 11 were considered 'economic' parameters, while the numbers 2,4,9,10,12,13 and 14 were regarded as more 'technical' in nature.

It is quite striking that styles of which the essence of the strategy can be most adequately formulated in terms that relate directly to specific farming practices (e.g. the buying of various inputs, labour-intensive versus labour-extensive practices) are characterized by a relatively strong emphasis on 'technical' parameters and norms. In those styles where such direct relations between essence of the strategy and concrete practices are less obvious, a relatively strong emphasis on 'economic' parameters and norms is found. Since all styles that have a negative contribution to the third discriminant function (see table 8.3) seem to grant primacy to economic parameters and norms, while those with a positive contribution tend to find technical parameters and norms more important, the interest in technical versus economic parameters and norms may be an adequate interpretation of this function (see section 8.4 for further elaboration).

The *nature* of the strategic considerations, then, seems to be partly associated with the farmers' orientations towards the market and technology (see figure 8.4). Along both the 'market' and the 'technology' dimension, one might speak of a continuum ranging from 'internal' to 'external' orientation. Those who -on the market dimension- consider 'taking care of cattle and pasture to perfection' (an 'internal' orientation) as most decisive for the future of the farm, adhere to a strategy that is defined in either technical or monetary terms. In contrast, those who tend to emphasize the importance of 'optimally adjusting to developments in the market' (an 'external' orientation), seem to have more pragmatically or competitively defined strategies. With the exception of the machinemen, the same holds for the decisiveness which is attributed to '... applying techniques on the basis of my own insight and experience ...' (an 'internal' orientation) versus 'keeping up to date with the newest knowledge and technologies, and translating these towards my own situation' (an 'external' orientation).

Finally, I have in relation to all parameters mentioned in box 8.1 of section 8.1, calculated the actual deviations from the DELAR norms in the 1986/1987 period. It appears again that the different styles tend to be characterized by different patterns of deviations, as is summarized in table 8.16. In section 8.4 I will discuss these patterns in more detail, and show that they can be interpreted reasonably well in the context of the strategies associated with each style of farming.

Table 8.16: Characterization of patterns in the deviations from the DELAR norms for each style of farming.

	characterization of deviation pattern
multiple goalers	lowest deviations right down the line
thrifty farmers	no clearly pronounced high or low deviations
practical farmers	a high deviation for a limited number of parameters, most of which with a clear direction (below or above the norm)
cowmen	a high deviation for many parameters, some of which without a clear direction (that is, high deviations above and below the norm)
machinemen	no clearly pronounced high or low deviations
fanatical farmers	a high deviation for many parameters, most of which without a clear direction (that is, high deviations above and below the norm)

8.4 Farming styles, DELAR-use and knowledge networks under the magnifying-glass

In the previous section I have roughly outlined some relevant characteristics and differences associated with the various styles of farming. In this section, I will discuss these in much more detail, and interrelate the various issues that I have so far touched upon in a rather fragmented manner. I will show that there are meaningful connections between, on the one hand, the way farmers use DELAR and structure their knowledge network (even if I have only sketchy material in relation to the latter), and on the other hand, the specific characteristics and strategic notions that are associated with the different farming styles (see also Roep et al., 1991). First, I will discuss the different styles separately, and towards the end I will identify and summarize some more general insights that emerge. It is necessary to present each style in great detail because such details are a crucial part of the empirical evidence. Those readers who find that the separate discussions are not related to their interest may consider to continue with earlier mentioned thematic summary at once.

The Multiple Goaler

The multiple goalers are relatively young farmers (average age 44), which operate on smaller farms (average 19 hectares and 42 cows) and have a comparatively small milk-quota (on average 243 tonnes). Half of the multiple goalers have a second branch (pigs or meat cattle). The most important idea underlying the operations of the Multiple Goaler is that the farm is to be organized in as independent a manner as possible. A farming system geared towards the production of both meat and milk is thought to be most suitable for achieving such a 'closed' organization. To this end, many multiple goalers use double-purpose cattle breeds (MRIJ) and seem to reduce costs even more than the thrifty farmers. Like the Thrifty Farmer, the Multiple Goaler is inclined to meticulously tune and coordinate the activities on the farm.

I have already shown that multiple goalers do not have much contact with the public extension workers, and that the latter tend to be rather critical with regard to their farm set-up, personal qualities and future prospects. Apparently, the multiple goalers do not fit the model of farming and farm development that extension workers find most appropriate. That multiple goalers are indeed evaluated against the background of a specific (and for multiple goalers rather alien) model is perhaps best illustrated as follows. Extension workers characterize their farms as relatively 'unbalanced' (table 8.8), while multiple goalers seem in fact to be pre-eminent fine-tuners. The impression, then, is that extension workers do not so much evaluate 'balance' in terms of the internal operations of the farm, but rather in terms of the market situation and/or political 'reality'; i.e they regard multiple goalers as lagging behind in development.

The characterization of multiple goalers as relatively 'unbalanced' does not only run counter to their inclination towards fine-tuning, but also to the actual DELAR results, since it appears that they positively distinguish themselves with the lowest deviations for almost all DELAR norms (see table 8.16 and appendix 1). This is in fact rather paradoxical; those farms that emerge as the most 'balanced' in terms of the DELAR model, are evaluated as being relatively unbalanced. Moreover, they are regarded as comparatively less able craftsmen, entrepreneurs and managers (see table 8.9). Even if extension workers may have grounds to assume that the enterprises of the multiple goalers are less viable given market conditions and present policies (e.g. they are relatively small size and less specialized), one could still argue that their evaluation is rather one-sided. After all, multiple goalers seem to reach high levels of technical efficiency.

The extension workers' assumption that the multiple goalers' future prospects are more problematic than those of others (see table 8.10), seems in fact to be shared by these farmers themselves. From the survey it emerges that they have less positive expectations than others in relation to their own future (see Roep et al, 1991). They tend to be uncertain about development opportunities, and show a great deal of interest in (agrarian) alternatives. In Roep et al. (1991), it is shown that this somewhat precarious position can in part be attributed to the built-in selectivity of governmental regulations concerning the environment and production limitation. Others (Vogelzang, 1989; Schreurs & Vrieler, 1988) point at a similar selectivity in regulations concerning farm succession and farm development. These regulations tend to either hit multiple goalers hardest, or provide them with less benefits.

The relationship between the multiple goalers and public extension workers is reciprocal in that the former -relative to other farmers- seem to expect least from the latter (see table 8.7). Many multiple goalers indicate that they do not find it important to regularly get advice from experts in general (50% of them finds that important, versus TF:69%, PF:83%, CM:71%, MM:43%, FF:69%). Similarly, multiple goalers seem somewhat less interested in farmer magazines and study clubs than other farmers. While farmer magazines may indeed be less geared to the interests of multiple goalers (and more to those of e.g. fanatical farmers and cowmen), their attitude towards study clubs is less easily interpreted. Even if multiple goalers highly value the ideas and information of colleagues, it appears that not one of them participates in a formal breeding and/or cattle study club. It may very well be that I have in my questionnaire missed some (possibly more informal) horizontal networks of farmers, which are of particular interest for multiple goalers (for example related to the breeding society, cattle markets, etc.). The breeding society seems indeed to be an important source of information for multiple goalers, which underlines their attention for breeding multiple purpose cattle.

DELAR-use

Many multiple goalers seem to have started using DELAR not only in order to get an overview of important parameters and/or in the expectation to improve results, but also on the basis of explicit advice from an extension worker. Sometimes, there even seems to be an undertone of 'doing a favour to an extension worker' in exchange for past and/or future services:

> "We started with DELAR a few years after we had built the new shed. The old extension worker used to drop by once in a while after we had finished it. According to him it was indispensable to have data of this, that and the other on a modern farm."

A relatively large number of multiple goalers have discontinued their use of DELAR (see table 8.12), mainly because they find that the usefulness of DELAR diminishes after a while, and -in relation to this- time investments become too high:

> "It was o.k., but after a few years you know how the farm is put together. All the same, there are quite some costs involved, and what, then, are you buying exactly? You get a lot of data and norms, but many of them you can't really change. We participated for four years, but it is a lot of administration, at least if you want to do it right."

Also, some multiple goalers are of the opinion that DELAR provides 'misleading' information in relation to specific parameters which are of particular interest to multiple goalers such as, for example, turnover and accretion per milking cow:

> "We always keep more young cattle than DELAR advises. We like to have a larger scope for selection at a later age, and we have the necessary space and fodder. Anyway, an in-calf heifer makes a fair bit of money; even if we may not make much of a profit, it is still a nice little money-box."

More than in several other styles, multiple goalers are inclined to use DELAR in order to compare with previous years:

> "The most important thing, according to me, is to compare your data with those of the previous year, and personally I look especially to the costs per 100 kilograms of milk. You need to reduce costs, and I try to do that by feeding more roughage and less concentrates."

Furthermore, they show a reasonable interest in comparing their results with other farms:

> "I do find those farm comparisons interesting. You can have a look where others are, and indeed ask them how the hell they can do it. You do indeed learn a few things in this manner. It appears, for example, that I am always low on spreading Nitrogen in comparison to others; last year I was even approaching 100 kilograms, but in that year I had been able to apply a fair bit of liquid manure due to all the rain we had. (...) I try to cut back on fertilizer; in the end Nitrogen isn't all that cheap either."

The actual interest in talking to other farmers about their results which is expressed in this last statement seems to be quite general among multiple goalers. In fact, 90 percent of them (as opposed to TF:46%, PF:54%, CM:76%, MM:71% and FF:75%) know the DELAR participant numbers of several other farms, which allows them to make *contextual* comparisons; that is, they can connect DELAR results with 'real-life' farms and farmers. Thereby they seem most interested in comparing with farms which have similar characteristics in terms of size and 'type' (see table 8.14):

> "For making farm comparisons it is best to look at farms with roughly the same number of cows and hectares."

Multiple goalers seem to be divided with respect to the importance of comparing with DELAR norms. An average percentage find this the most interesting type of comparison, but a relatively large percentage see it as the least interesting manner (see table 8.13).

In all, it appears that the way multiple goalers use DELAR coincides well with their attention for, and interest in, the internal dynamics of their farms (see figure 8.4). When comparing with others -instead of with previous years- they seem to be looking for farmers with a similar orientation; at least, they reject comparison with farms that have 'remarkably good results' (see table 8.14).

Attitudes and position vis-à-vis DELAR norms

Like others, multiple goalers indicate that they use DELAR norms as points of reference for setting enterprise goals. Thereby they emphasize particular aspects. More than others, multiple goalers argue that concentrate feeding during both the stable period (MG:40% versus TF:23%, PF:25%, CM:12%, MM:43% and FF:44%) and -even more importantly- the grazing period (MG:60% versus TF:38%, PF:33%, CM:24%, MM:43% and FF:44%) should be below the DELAR norms. Thereby, they firmly stress that additional fodder costs should remain right on the norm (MG:90% versus TF:38%, PF:21%, CM:58%, MM:14% and FF:44%). It is hardly surprising, then, that the majority indicate clearly that the mowing percentage should be above the DELAR norm (MG:60% versus TF:23%, PF:38%, CM:29%, MM:57% and FF:31%). Furthermore, a considerable number of multiple goalers (30%) indicate that a norm for young cattle density does not make sense, and the majority of the rest (MG:40% versus TF:15%, PF:29%, CM:39%, MM:17% and FF:38%) argue that young cattle density should exceed the DELAR norm. Thereby, a relatively large number of them (MG:30% versus TF:0%, PF:13%, CM:6%, MM:14% and FF:13%) agree that costs on milk products for calves should be higher than the norm (which in practice often means that calves get raw milk[18]). Similarly, quite a few multiple goalers want the expulsion percentage for milking cows to be lower than the norm (MG:40% versus TF:31%, PF:17%, CM:12%, MM:0% and FF:31%; an additional 30% find this norm useless), whereby they maintain that total turnover and accretion per milking cow needs to be either on the norm (50%) or above (50%) the norm.

It is quite striking to see that these emphases are clearly linked to their strategy of maintaining (input market) independence: e.g. the emphasis on own fodder production as against concentrate feeding; feeding calves with own milk rather than milk replacer; and being economical with cattle. At the same time these accents reflect a strong attention for 'technical' rather than for 'economic' parameters and norms. This seems indeed to reflect a rather practical way of translating the ideal of the 'closed' farming system.

The actual results (1986/1987) achieved by the multiple goalers reveal their particular strategy and goals as well. When compared to others, they attract attention with their on average relatively low Nitrogen use; low concentrate consumption during especially the stable period; low feed costs per milking cow; low total fodder & feed costs; a low expulsion percentage for milking cows; and a higher turnover and accretion per milking cow, due to a relatively high percentage of calves born and higher selling prices for both calves and cows. Furthermore, milk yields per cow are relatively low, as is the case with revenues per milking cow, and revenues minus feed & fodder costs per hectare. Due to the widespread (70%) use of pure MRIJ cattle (a double purpose cow), ages at first calving are relatively high (see appendix 1 for details).

A remarkable picture emerges when the multiple goalers' deviations from DELAR norms are analyzed. For no less than 9 of the 12 norm-deviations that were calculated[19] the multiple goalers are characterized by the *lowest* deviations in absolute terms[20], whereby in all cases they distinguish themselves positively from others. For example, the multiple goalers remain closest to the feed costs and fodder costs per milking cow, while others -on average- exceed these in a considerably larger measure. Similarly, they achieve by far the most favourable deviations for important parameters such as revenues minus feed & fodder costs per cow and per hectare. In terms of additional feed & fodder (expressed as kilo-VEM) provided per hectare of grazing land, they are the only ones with an on average negative deviation from the norm. This indicates once more that relatively little use is made of external inputs, and/or that the grazing land itself is used quite efficiently.

Earlier in this section, I have already mentioned the paradoxical implications of these relatively low deviations from the DELAR norms. Given the impressions from the qualitative interviews, the relatively critical attitude of multiple goalers towards comparison with norms, and the goals that they formulate in relation to these, it seems that the low deviations are not so much the result of an explicit attempt to achieve these norms, but rather that they are a somewhat 'accidental' outcome of the strategies and practices which they employ. Indeed, the DELAR model has from the outset been developed as a tool to help farmers analyze feed and fodder costs with the aim of *reducing* them. Thus, the philosophy underlying the model matches well with the core strategy of the Multiple Goaler, which may explain why they fit the model best. Another explanation may be that it is more easy to meet the norms at lower levels of intensity. This interpretation, however, is contradicted by one of the designers of DELAR, who argues that:

> "At higher levels of production the deviations of the norms rapidly tend to become smaller. A cow which produces 10,000 litres of milk [a large amount, CL] will usually be fed below the norms; if you would feed her according to the norms she would get upset. In addition, farmers that are able to reach high levels of production are bound to do very well with pasture and roughage, which means that here too they cannot deviate too much from the norms."

The Thrifty Farmer

The thrifty farmers also operate on somewhat smaller farms (on average 20 hectares, 42 cows and milk-quota of 269 tonnes). They almost exclusively use the pure MRIJ breed of cattle (92%), and more than 90 percent of them have a pig unit as well; in this sense they are more 'multiple goalers' than the multiple goalers themselves. With an average age of 50 years, they are somewhat older than farmers from other styles of farming. Like the Multiple Goalers the Thrifty Farmers tend to be fine-tuners with a strong emphasis on the production of roughage and pasture management. Although their thrift has clear connections with the input-market independency strategy of the Multiple Goaler, there is, at the strategic level, a subtle but clear distinction between the two. In the reasoning of the Multiple Goaler, the explicit aim is to create a self-sufficient farm in the *technical* sense, while the Thrifty Farmer emphasizes the *monetary* dimension. The monetary costs should be as low as possible, unless these are compensated with very clear monetary revenues; the idea is that money should not be *wasted*. Below, I will show that this subtle difference is especially reflected in different ways of using DELAR.

Even if extension workers indicate that quite a few thrifty farmers could improve the efficiency of stables for milking cows, farm buildings and machinery (perhaps because they find that thrifty farmers have cut back on expenses too much), they evaluate their pasture management, balance in organization and personal qualities in a reasonably positive manner (see tables 8.9 and 8.10). Although thrifty farmers themselves express a fair interest in a variety of sources, and -relative to others- especially private extension and DELAR group meetings, they are, in practice, hardly more involved with the public extension service, study clubs and DELAR group meetings than the multiple goalers. Also from the qualitative observations, it emerges that they tend to have a rather tepid attitude towards most sources of new ideas and information, whereby they -in conformity with figure 8.4- stress the importance of their own experience and ideas:

> "We used to be a bit too high with concentrate feeding and fertilizer. In part, DELAR has caused that we have changed that, but of course not everything has been set on its legs in this manner. I am not following such a figure just like that. You need your own ideas as well."

One could describe the Thrifty Farmer as a rather self-willed type of person, who is relatively sceptical and/or indifferent to various sources of information, including colleagues and -in particular- specialists.

DELAR-use

Thrifty farmers have started to use DELAR with the expectation of improving enterprise results, and it seems that -as was the case with multiple goalers- extension workers have been influential in creating this expectation as well. Over time, quite a few thrifty farmers became disappointed; 38 percent had already stopped DELAR participation in 1989 and an additional 20 percent indicated that they were not sure whether they would continue in the future. Again, the most important reason for discontinuation is that DELAR does not provide much new insight when used over a prolonged period:

> "In the starting years I had just built the new stables, and I had to really learn how to work with it. I was, for example, feeding far too much concentrate, and I should have made more use of roughage. DELAR helps to learn this, but later on I became reasonably organized, and did not deviate too much from the norms. Well, you keep some minor deviations, but that holds for everybody."

And how typical:

> "It became too expensive. It easily costs 300 guilders per year, plus some 25 guilders for the record-book. We already have an accountancy bureau, and to my mind it became too costly to have DELAR as well. Besides, DELAR is all about the cow and feed & fodder; contractor costs are, for example, not calculated; it is only the feed & fodder costs that are taken into account. (...) We started in '81, and then it was still very simple, but the last few years it has grown more complex as well, so that it takes more time to fill up the record-book."

Besides, DELAR has certain limitations from the perspective of true fine-tuners:

> "Of course it has been useful to a certain extent; I could see what *-on average-* I was saving per cow, and now that is not so easy any more, but I don't really miss it. (..) In the end you need to make sure that you get rid of the bad cows, and DELAR doesn't say anything about that."

The strongly diversified character (cattle and pigs) of these farms, in contrast, provides arguments -again formulated in monetary terms- for continuation of DELAR-use:

> "I have a partial administration for both the sows and the cows, so that I can see where the money comes from, and where it goes."

Thrifty farmers -in contrast to multiple goalers- are not particularly interested in making comparisons with previous years. It is possible that they find themselves in a less precarious position than multiple goalers (from the survey it emerges that they are much more confident about their future prospects than multiple goalers, see Roep et al., 1991), and/or that they are a bit older and more opinionated. Thus, they do not have to pay too much attention to changes that occur from year to year. However, they show a relatively strong interest in comparing with others; 23 percent explicitly mention this as a reason for DELAR participation, even if this answer was not included in the closed question (see table 8.11).

> "When we moved the farm, paying attention to DELAR came under pressure, but I can still see the use of it: the comparisons between your own results and those of others. It is very important to get an overview of your results, and discuss these; amongst others with the extension worker.

By the way, he used to take the initiative to visit himself, but now you have to call for him yourself."

This interest in other farms seems, at first sight, somewhat contradictory to their relatively limited interest in the ideas of colleagues. However, I have shown (in table 8.14) that -next to comparing with group and/or overall averages- the thrifty farmers are quite interested in comparisons with specific farms that in their view have remarkably good results. In addition, it appears that relatively few of them (TF:46% versus MG:90%, PF:54%, CM:76%, MM:71% and FF:75%) are aware of one or more DELAR participant numbers, while participation in DELAR group meetings is not too high either (TF:50% versus MG:60%, PF:63%, CM:56%, MM:43% and FF:73%). This supports my more qualitative observation that when thrifty farmers compare with others, the comparisons remain often *numerical*; that is, in contrast to multiple goalers, they are not so interested in the specific *context* from which the data are derived:

"The most important thing about DELAR is the information you get on your own farm. Besides, there is the comparison with farms that do really well. In DELAR meetings they explain how they do it, *but you derive much more from analyzing the data than from the discussions.*"

Thereby, they tend indeed to focus on monetary issues:

"The parameters that I look at first are the costs per litre of milk, the costs made for roughage, and those on fertilizer. Costs play a very important role in determining the income. In school I have taken good notice already of the law of diminishing returns."

Thrifty farmers indicate that they find comparing with the norms important, but at the same time they show a considerable amount of relativism:

"Those norms, they are of course only averages. They are written down on paper, but you can't really say much about it, since you don't know the circumstances on other farms."

"Turnover in itself is not that important. The idea is to optimize revenues minus costs. In this process, the norms are only used as a *handle*, in order to detect where things may be wrong. We have never really worried about whether or not the norms are correct or not."

Attitudes and position vis-à-vis DELAR norms

The thrifty farmers emphasize that additional fodder costs should be below the norm (TF:46% versus MG:10%, PF:46%, CM:21%, MM:57% and FF:31%), while revenues minus feed & fodder costs should be above the norm level. Thereby, they especially stress the importance of achieving higher revenues minus feed & fodder costs *per hectare* (TF:77% versus MG:50%, PF:63%, CM:44%, MM:50% and FF:40%).

"First of all the parameters concerning revenues minus feed & fodder costs are very important. Especially the revenues from our own land used to be a bottleneck when we started here, but we have really caught up on that."

The emphasis on results *per hectare* contrasts sharply with, for example, the strategy of the Machinemen, who consider the farm size to be a flexible variable which can be easily increased when needed. Therefore, the Machinemen do not regard the revenues minus feed

& fodder costs per hectare as an important (or reliable) parameter (only 57% of machinemen find it an important parameter, versus TF:100%, MG:90%, PF:88%, CM:79% and FF:88%) (see also Roep et al, 1991).

Other accents that come to the fore are that, according to thrifty farmers, the expulsion percentage for milking cows should be at the norm (TF:54% versus MG:30%, PF:33%, CM:24%, MM:50% and FF:44%). This means that they are less focused than the multiple goalers on reaching prolonged lifetimes for milking cows. Apparently, replacing cattle is justified when sufficient revenues can be expected. Furthermore, in comparison to the multiple goalers especially, thrifty farmers find both the norms for costs on milk products on calves, and those for young cattle density, of less importance (the first is deemed important by 69 percent of thrifty farmers versus 100 percent of multiple goalers (PF:88%, CM:53%, MM:86% and FF:81%); for the second norm the respective percentages are TF:38% versus MG:60%, PF:75%, CM:68%, MM:29% and FF:56%). Apparently, these things can be dealt with in a more flexible manner when starting from a monetary/thrifty strategy.

Indeed it emerges that, to the extent that they use the norms as a point of reference to formulate goals, thrifty farmers -in contrast to multiple goalers- focus more on *economic* rather than *technical* parameters.

The actual results of thrifty farmers attract attention in that they have relatively low fodder costs per milking cow (and indeed the lowest number of milking cows per hectare), in juxtaposition of which they feed a relatively high amount of concentrates in the stable period. This can be explained from the fact that thrifty farmers tend -in order to get higher prices- to concentrate their milk production in the wintertime (see Roep et al, 1991). In all, they achieve the lowest feed & fodder costs per 100 kilograms of milk, and the highest revenues minus feed & fodder costs per milking cow. This latter figure is accomplished amongst others with the help of the highest turnover and accretion per milking cow, which in turn is related to high prices for calves and milking cows. Finally, the thrifty farmers are characterized by relatively high age at first calving (a characteristic of MRIJ cattle), and a high percentage of new (self-bred and/or bought-in) cows entering the herd (see for details appendix 1).

With respect to deviations from the DELAR norms, thrifty farmers do not have a very pronounced position. They tend to come rather close to the mowing percentage norm (while most others tend to mow more). Despite their lowest feed & fodder costs per 100 kilograms of milk, they have surprisingly the highest deviation of the norm in this respect (costs are still too high according to the DELAR model). A similar phenomenon occurs in relation to revenues minus feed & fodder costs per milking cow. These results may be connected in that thrifty farmers have the highest deviation in terms of fodder costs per cow as well. For reasons that cannot be reconstructed from our material, thrifty farmers apparently have grounds to cut back on their own roughage production (amongst others by mowing less than others) and buy some additional fodder. It may be, for example, that they have less machinery, and find the buying of roughage cheaper than hiring a contractor to do the work. Despite all this -and as I have shown earlier on- they still manage quite well to keep the fodder costs per milking cow at a relatively low level.

In fact, the rather 'colourless' position of the thrifty farmers vis-à-vis the DELAR norms means that they are doing quite well. As was the case with the multiple goalers, this is hardly surprising since the rationality behind the DELAR model is to balance costs and benefits, which is indeed the major preoccupation of the Thrifty Farmer.

As was the case with the multiple goalers, it can again be concluded that the goals which thrifty farmers formulate in relation to the norms can be interpreted reasonably well against the background of their strategy, and that this strategy, in turn, is reflected quite clearly in their actual results (see also Roep et al., 1991).

The Practical Farmer

The practical farmers tend to be younger farmers (on average 42 years of age) that run larger scale farms (on average 22 hectares, 52 cows and milk-quota of 340 tonnes). With only about 40 percent of them having a second branch, the are the most specialized style of farming. Only 50 percent of them use the pure MRIJ breed cows, while 37 percent use Friesian-Holstein and Holstein-Friesian cattle (typical milking cows). In 1986, a high percentage (PF:58% versus MG:20%, TF:38%, CM:38%, MM:29% and FF:50%) of them were practising in-house-summer-feeding. At the strategic level, the Practical Farmer tries to organize the farm in such a way that it can be adequately controlled and taken care of (see Roep at al, 1991). As I will show, their pragmatic attitude is not only reflected in the way they handle the (labour) organization of their farms, but also in their dealings with DELAR.

It has already emerged that the practical farmers are in frequent contact with public extension workers (see table 8.6), and that their personal qualities especially are highly valued by the latter (tables 8.8 and 8.9). In general (see Roep et al., 1991; and also table 8.7), it seems that practical farmers gravitate towards a wide variety of sources. In addition to extension services, they have considerable interest in other sources of new ideas and information such as farmer magazines, private extension and specialists. A large percentage (83%) find it important to get regular advice (versus MG:50%, TF:69%, CM:71%, MM:43%, FF:69%). Colleagues are quite highly valued as well, which is reflected in that -relatively speaking- many practical farmers participate in a cattle or breeding study club (PF:46% versus MG:0%, TF:25%, CM:35%, MM:43% and FF:27%), while the majority take part in DELAR group meetings as well (PF:63% versus MG:60%, TF:50%, CM:56%, MM:43% and FF:73%).

> "With the help of the DELAR lists, I try every year to identify some points on which I am not up to standard. Out of these, I pick one that I try to give extra attention. I do not discuss the results with some specific person. I talk to anybody and do everything that may help me to learn something. I want to acquire new knowledge, for example, how can I influence the environment in such a way that I can produce more without spending too much money."

As I will illustrate on several other occasions as well, the Practical Farmer is pragmatic, and tends to have a very open and non-dogmatic mind and attitude. This seems to be reflected in that they do not clearly take a position in terms of their orientation towards technology (see figure 8.4). The Practical Farmer tends to dislike one-sidedness:

"There aren't many study clubs around, except for some that focus on breeding, but well, these are so one-sided. A more economic thing like DELAR, that is of more use to me."

DELAR-use

The Practical Farmer tends to like figures, which seems to be related to the fact that a clearly demarcated strategy (in terms of technical or economic results) is lacking. Thus, time and time again it must be (re)analyzed what is best for the farm.

"At the moment DELAR is useful now that it emerges that the revenues minus feed & fodder costs per cow are on the increase, while the total revenues minus costs are not. That means, for example, that it is not so much the production that needs to increase, but rather that I have to try to adjust the percentage of protein. Furthermore, I have to work on the feed & fodder costs. Trying to increase turnover and accretion would be another possibility, since that too is part of the total revenue."

Therefore, it is not surprising that practical farmers are quite satisfied with DELAR; only 17 percent had discontinued using DELAR by 1989. The interest in figures, and the pleasure derived from working with them, is also exemplified in the fact that the great majority (PF:83% versus MG:60%, TF:54%, CM:79%, MM:57% and FF:75%) indicate that they would find it stimulating if DELAR would include environmental parameters. Also from my qualitative observations it emerges that practical farmers are dealing quite consciously with figures, which is at the same time reflected in a rather critical attitude:

"I am not very satisfied with the DELAR norms. Especially with regard to the calculations in relation to concentrate-use I have my doubts, as is the case with averages per milking cow. Last year I have calculated everything myself, and I arrived at totally different results. The extension worker claimed that I was dealing with subordinate issues, but I really think the DELAR calculations are *wrong*. Take, for example, concentrate feeding during the summer. The stocks at the beginning of May, and those on the first of November are taken into account for the calculation thereof. But when you have got a lorry load of concentrate towards the end of October, the calculation is not right at all. The total figure is all right, but the division between summer and winter is distorted, and that causes a false picture with regard to the norms as well. Yet, these small mistakes have major consequences."

More than others, practical farmers intend to buy their own 'integral' MSS on a personal computer. No less than 74 percent (versus MG:20%, TF:31%, CM:44%, MM:71% and FF:36%) claim to have plans in that direction, even if only one had actually bought such a MSS already in 1989. The advantage of such a system, according to them, is that it enables better and faster intervention in the farm. The Practical Farmer wishes to know continuously what is happening, so that -if necessary- corrections can be made.

"In order to have a decent overview you need to work with one or the other computer program. If something appears wrong, you know at least where to search. The advantage of those management systems is that it is possible to detect mistakes and change the farm organization accordingly. Thereby, it is really important to be very accurate with figures. Some people don't like figures, but in the future you will need it anyway."

"The major advantage of the management computer is that decision making is sped up. I enter the number of litres from the milk inspection into my own management computer the next day; it still takes another ten days before I receive them back from Lochem. Also, it emerged from COMRU that we had too high an in-between-calving-time; 397 days. COMRU indicates on the attention lists which cows have not been seen in heat in 30 days. After 50 days, I ring the veterinarian. Now, after two years, we have an in-between-calving-time of 375 days, and we are aiming at 365, since what we really want is one calf per cow per year. (...) *The point is that we had too little control earlier on.*"

Comparisons with previous years are very important to practical farmers (see table 8.13), which seems to coincide well with their very flexible attitude towards change. The tactics of the one year need to be *evaluated* against those of the previous years.

"The principle underlying production is 'a little bit of everything'. You try to arrange things in such a way that optimal production is possible. Of course, you need to earn a bit of money in doing so, and that is why revenues minus feed & fodder costs per cow need to increase. This year the revenues minus feed & fodder costs were on the increase, while the total revenues minus costs were not. *You need to address the question whether or not you need to continue in the same way.* That is the fun of DELAR, that you can see all these things."

"In fact, DELAR always lags behind the actual farm organization. To me, it is sort of a control of what I am doing at the moment, in relation to what I was doing the previous year. Until three years ago we were practising in-house-summer-feeding. We have changed that first, and then you look with the help of DELAR if it is profitable or not."

The Practical Farmer seems in fact quite happy when the expectations come true, whereas a Multiple Goaler might in such a case argue that DELAR has again not provided new insights at all.

"The parameter that I look at first is concentrate feeding per cow, and I compare that to the norm. It is *funny* to see whether or not it fits. In one year you need, for example, to compensate for the bad weather by feeding a bit more, and it is nice if you can find that back in the figures. In a good year, of course, you shouldn't exceed the norms. We have been at or below it for years now."

Some of the practical farmers seem to have a great deal of interest in comparing with others. Not unlike the thrifty farmers, a relatively large percentage (21%) explicitly mention this as a reason for DELAR participation, even if this answer was not included in the pre-structured question (see table 8.11). When comparing with others, they are especially interested in those farms who resemble them in size and 'type', but also in farms that they are well acquainted with and/or with farms that have -in their view- exceptionally good results. Its seems that -in contrast to for example the Thrifty Farmer- the Practical farmer is much more interested in making *contextual* comparisons. In other words, they are interested in the farm and the farmer behind the figures.

"The comparisons with your own farm are by far the most important; then you really know where the figures come from. Still, those discussions with other farmers were quite nice, especially for hearing *why* people do things differently."

"The most important part of DELAR is the information concerning your own farm, and with all these data you have a lot of things to talk about with other farmers. What the other is feeding, and how he achieves particular things. I must say that it is quite an experience; for while talking about it new things emerge, which allow in turn for more discussion."

Thereby it seems that they have an interest in people that organize their farm in ways that are alien to them, which exemplifies again their open mind and flexibility.

"When I receive the DELAR print-out, I compare the results with the norms first, and then with the results of the previous year. All these things are in fact printed on the one form. Next, I search for a farm of which I know a little, and that resembles mine. Besides, I look for the results of farms of which I know that they have a different feeding regime. I also look at the results of groups of farms. (...) For me the main thing is that I can learn something. I still know far too little, and I have no problem whatsoever to be open about my figures. The taxes I will pay anyway."

"Each year the extension service organizes that we meet with a fixed group in order to discuss the results. Earlier on we always knew which results belonged to whom, but at a given point someone objected to that, and now we do without that. Each year we meet at a different farm, and from that farm, of course, we get all the data. You always learn one or two things from someone else's experience."

Of all styles of farming, the practical farmers are least interested in comparing with the DELAR norms (see table 8.13). Again, this seems an expression of their non-dogmatic outlook. "Many roads lead to Rome", seems to be the motto, and this leads them not to worry too much about them.

"Sometimes, however, I have my doubts about the norms, and I really ask myself where they have got them from. The extension worker of the feed industry tells me that the norms for concentrate feeding are too low, while the regular extension worker argues that they are o.k. like this. They all have their own norms; maybe the feed industry has higher norms because it suits them. I don't know. Those norms are sometimes very sharp, and therefore I look at them as points of reference that you could strive for. I am not too concerned about the norms, for they are reference points; no more than that."

"We are usually quite close to the DELAR norms. If you end up below the norms, you think about it, but there is no direct reason for panic. Of course, those norms do not come out of the blue; you need to trust them a little. I assume that they are based on research all right."

Two other Practical Farmers refer to more specific situations in which they disregard the DELAR norms.

"Those norms are quite o.k. in theory, but in practice things often turn out differently. Sometimes you choose to follow your own insights, for example in relation to rearing young cattle. According to the DELAR norms I have twice as many young cattle than I should, but I have the roughage, so why would I sell calves or yearlings, or change my ways of roughage production? *My logic in relation to young cattle is simply different than the vision adopted in DELAR.*"

"The norms aren't always correct either. I participate in the Coupling Milk Inspection Cattle Feeding as well, and I tend to stick close to that. Still, I always end up above the norms in DELAR. With feeding milk to calves I am always above the norm as well. I don't worry too much about it; I am satisfied as it is. Besides, everybody with a high production exceeds those norms, so I don't care much."

Attitudes and position vis-à-vis DELAR norms

I have already shown that the Practical Farmer does not pay a great deal of attention to the DELAR norms. Thus, it is not surprising that there quite a few norms that they -in comparison to others- find relatively unimportant. This holds, for example, for the norm for additional feed & fodder costs per 100 kilograms of milk, which is labelled 'unimportant' by 46 percent of practical farmers (versus MG:10%, TF:23%, CM:12%, MM:57% and FF:19%). In different degrees, the same holds for the norms for fodder costs per milking cow (PF:33% versus MG:10%, TF:23%, CM:24%, MM:29% and FF:25%), mowing percentage (PF:54% versus MG:30%, TF:46%, CM:50%, MM:43% and FF:44%), concentrate feeding during the grazing period (PF:21% versus MG:0%, TF:8%, CM:15%, MM:14% and FF:6%). Norms that particularly practical farmers label as 'important' are young cattle density (PF:75% versus MG:60%, TF:38%, CM:68%, MM:29% and FF:56%), and also the various norms concerning revenues minus feed & fodder costs[21]. In relation to these latter norms, they indicate more than others that both revenues minus feed & fodder costs per hectare (PF:63% versus MG:50%, TF:77%, CM:44%, MM:50% and FF:40%) and for the enterprise as a whole (PF:75% versus MG:50%, TF:54%, CM:44%, MM:71% and FF:40%) should be above the norm. A Practical Farmer confirms the importance of these parameters in the next quote, in which he expresses a fair amount of pragmatism as well:

"The parameters that I look at first are revenues minus feed & fodder costs per cow, for the whole farm, and per hectare. Parameters that I can't really work with are those concerning kilo-VEMs that I am feeding with roughage and concentrates. They tell me nothing; I mean I can't do much with them. They give me no direction. When the grass is good, I cut it. When the quality is not good, it needs to be compensated with concentrates. It is as simple as that."

The attention paid to economic parameters seems to fit well with their relatively strong orientation towards the market (see figure 8.4). The economic evaluation of certain practices seems to have a higher priority than the ideal of reaching technical perfection.

"The most important parameters are the revenues per cow, and the revenues minus feed & fodder costs per cow and in total. For that is were the money has to come from; that is what you are working for. All the other variables are important as well, but they are subordinate to the ones I mentioned."

In actual practice, the practical farmers -in contrast to the thrifty farmers- are characterized by a high number of milking cows per hectare, and the highest fodder costs per milking cow (which causes them to have high total feed & fodder costs, and the highest feed & fodder costs per 100 kilograms of milk as well). Apparently, in reaching a relatively high degree of intensity, practical farmers prefer to use and buy roughage rather than concentrates. This is also reflected in very high mowing percentages (which is without doubt related to in-house-summer-feeding). Prices made for cows (when expulsed) are relatively low. In all, however, the practical farmers manage to obtain the highest revenues minus feed & fodder costs per hectare (see appendix 1 for details).

When looking at the deviations from the norm, one sees that the practical farmers have the highest positive deviation from the norm for mowing percentage. Also, it is quite striking that despite low prices for cows they still reach a much higher turnover and accretion per milking cow than the DELAR norm (even if this parameter is obviously much lower than in case of the multiple goalers and the thrifty farmers). In terms of the feeding of concentrates during the stable period there is a fair amount of dispersion, which is reflected in a high deviation from the norms in absolute terms. With the exclusion of the latter parameter, most deviations from the norm have a rather clear direction. Therefore, it can be concluded that, despite their pragmatism, flexibility and the fact that practical farmers do not have a clear-cut strategy in technical terms, they tend to have more homogeneous farm operations than, for example, the fanatical farmers. Although in terms of the figures 8.2 and 8.4 (and also in various other ways as I will show later on) the practical farmers are closest related to the fanatical farmers, there seem to be clear differences as well. This conclusion is only supported by the lack of overlap between the two styles in figure 8.3.

The Cowmen

In terms of hectares (on average 20) the cowmen belong to the smaller farms, whereas in terms of the number of cows (44) and especially milk quota (306 tonnes) they tend to be larger than thrifty farmers and multiple goalers. The average age of cowmen is 46 years, and about 55 percent have a second branch. Only 44 percent of cowmen use pure MRIJ breed cows.

Cowmen organize their farm around the cow (see also Roep et al., 1991). Reaching a high milk yield per cow is a crucial objective for cowmen, and this is to be achieved with the help of a high labour input per animal, and high levels of feeding. Below, it will emerge that their clearly demarcated production goals and considerable attention for individual animals is markedly reflected in the way they work with DELAR, and the problems they face in relation to it.

Extension workers and cowmen tend to be in regular contact (see table 8.6), and the former are especially positive in the evaluation of the latter's future prospects, the efficiency of available machinery and pasture management, and personal qualities such as craftsmanship and entrepreneurship (see tables 8.8 to 8.10). Like the practical farmers, the cowmen are relatively interested in a wide variety of sources (see table 8.7). A relatively large number participate in a breeding study club (CM:26% versus MG:0%, TF:8%, PF:21%, MM:14% and FF:27%). The interest in the DELAR group meetings seems to be mixed, which -as I will show later on- seems to be related to particular ideas concerning the usefulness of making comparisons with others on the basis of DELAR. Although, like the Practical Farmers, the Cowmen tend to widely orient themselves, they will appear to be more selective than the former, for they have rather strict ideas about what -in technical terms- the results of the farm should look like, and how this is to be achieved.

DELAR-use

The cowmen have started using DELAR with the clear expectation of improving results (see table 8.11). In contrast to especially thrifty farmers and multiple goalers, many do not agree with the proposition that after a while DELAR ceases to provide new insights (CM:59%

versus MG:30%, TF:15%, PF:46%, MM:43% and FF:44%). Nevertheless, cowmen often indicate that the information DELAR provides is not specific enough to guide intervention at animal level.

> "We would like to have some more specific data, such as a cost price calculation per individual cow. That would be interesting. Now DELAR calculates that it is 55 cents per litre of milk, but that doesn't mean that that is the same for every cow. On a relatively small farm such as ours, relatively bad results from one cow can bring down the average result a lot. You only need one extreme case, and the numbers aren't correct any more. (...) The number of cows is too small, and therefore the average figures are too *rough*. When, for example, you look at the average number of inseminations needed to get a cow in-calf, and one cow gives a lot of trouble, you might still think that there is a general fertility problem in the herd. In reality the problem lies with one single cow, so we would prefer to have those parameters per individual cow. For example, feed & fodder quantities, milk money per cow, and fertility[22]. (...) When I sell the calves an average price of 624 guilders is not all that informative. The one Piemontee calve that I sell for 900 guilders can lift the whole result. *Especially those important differences and particularities DELAR cannot grasp*.

The lack of detailed information not only holds in relation to the cows:

> "We sometimes make silage in intervals, and only 1.5 hectare each time. The quantity of silage as it is estimated by DELAR; that is, according to length, width and height, is not very relevant, for when I compare different parts of the silage pit I can see clear differences in quality. Such differences in quality are not accounted for in DELAR."

By 1989, 24 percent of the cowmen had discontinued DELAR participation. As reasons some of them mention that DELAR ceases to provide new insights, but some also indicate that they have other priorities with respect to their time allocation:

> "After a while you know what are the weak points, and where improvements are to be made. Moreover, the registration of all those data takes a lot of time, *which is better spent on the cows*. Everybody says: "If you only spend ten minutes per day on it, there is no problem." But the man you buy your machinery from says exactly the same, and thus there are a lot of things on which you have to spend 'only' ten minutes per day. If you add it all up you are busy for hours, and then the real work hasn't even started yet."

Also, misleading ways of calculating parameters and norms are mentioned as a reason for discontinuation. Some of these are again related to the intensive care that cowmen surround their animals with.

> "In DELAR, I miss an accounting for the veterinary costs. You can get very nice results, but if that requires the constant calling in of veterinarians, there is still something wrong. When my cows get an udder infection I try to use as little penicillin as possible. I rather milk them eight or nine times a day in order to get it right again. Penicillin encapsulates the infection, and then you can't get rid of it any more. With penicillin you have a risk of getting a high cell-count in the milk as well, and that isn't too good either."

It emerges that cowmen tend to have a somewhat ambivalent attitude towards figures. On the one hand, they cannot do without (whereby they are more interested in individual figures than in averages), but on the other hand, they find it rather time-consuming, and moreover:

> "The administration has never interested me that much; I don't enjoy it. I sometimes wonder whether you can really farm better with a computer and all those data. I mean if you are really a better farmer with all that. (...) *Whether or not things are all right I can tell from what the cows look like.*"

But still:

> "We have thought about discontinuing DELAR. But well, it will probably remain important in the future to have data on the farm, and to compare them with previous years."

This in part explains that, despite the fact that in theory on-farm 'integral' MSS might - through the provision of data per individual cow- suit them quite well, they remain hesitant to really invest in it. Forty-four percent (44%) of the cowmen intend to buy a management computer, which is considerably higher than the multiple goalers (20%) and thrifty farmers (31%), but much lower than practical farmers (74%) and machinemen (71%).

As the last quote already indicates, cowmen -next to comparing with norms- have a particular interest in comparing with previous years (see table 8.13).

> "It is hard to indicate which parameters are crucial to us. Milk yields per cow, and especially revenues per cow are important. We only make comparisons with previous years. We get some material on other farms too, but in fact we don't use those at all."

Very little attention is paid to comparisons with other farms (see table 8.13); this despite the fact that they find colleagues an important source of information and ideas (see table 8.7). In part, this may be related to the lack of specificity of DELAR parameters and norms; those things that would be interesting to compare cannot be compared on the basis of DELAR. In relation to this, cowmen frequently point to the lack of contextual information provided by DELAR itself and/or in the DELAR group meetings.

> "I once went to a meeting in Winterswijk where all participants were invited to come, even if they didn't all show up. (...) I find the comparisons with others less interesting than my own figures; it is only interesting for guessing which figures belong to whom, and in order to satisfy your curiosity about how others are doing. For you know neither the backgrounds of the figures, nor what the motivation of the farmer is for doing what he does. Thus, those figures say nothing."

Some cowmen add reasons related to privacy and reciprocity as well, whereby this particular cowmen indicates that there are other ways to get information on others as well:

> "Some people, of course, never say a word anyway. I would never mind about the extension workers, but in relation to colleagues I would argue that they really needn't know everything. (...) Comparing and discussing with the extension worker is indeed important; anyway, he knows how others manage to reach particular figures too."

If comparisons with others are made at all, cowmen compare primarily with averages of a particular group of farms, and with farms which they consider to have remarkably good results. It is quite striking that, more than others, cowmen seem to have very specific criteria for the selection of groups: in addition to size, they consistently mention the number of milking cows per hectare (stocking density), breed of cattle and milk yield per cow.

"It is better to compare with data from previous years and the norms. For example, I exceed the norm for feeding costs with 10,000 guilders, but at the same time I am 15,000 guilders below the norm for fodder costs. When I do compare with others, I look first for farms with a similar milk yield, and then I check whether they are above or below the norms for feeding. The majority is above the norm, including, by the way, those with lower milk yields."

In all, it seems that -not unlike the Thrifty Farmer (but for different reasons)- Cowmen make *numerical* rather than *contextual* comparisons. Given the parameters provided by DELAR, they tend to select farms primarily on the basis of milk yields (which in their strategy is indeed a crucial parameter) and check whether or not they are *more or less in line* with others.

"You should be looking primarily at your own farm. Not everything is comparable, and that is why I look at farms with the same stocking density or the same production per cow, and also at someone who is doing better than I am. I know of a farmer who -with the same number of hectares and a milk yield of only 6,000 kilograms- achieves the same income. Apparently that is possible. You look a bit whether or not you are more or less in line with other farmers."

Given the importance attributed to information provided by colleagues, however, one may expect that in other contexts -such as the breeding study club- cowmen do indeed exchange more contextual information.

Attitudes and position vis-à-vis DELAR norms

In relation to the DELAR norms, cowmen worry especially about the norms that are related to concentrate feeding. This is not much of a surprise, for there is a strong relation between concentrate feeding and milk yields per cow. Moreover, cowmen do indeed have by far the highest feeding costs per cow. Thus, for them it is a real puzzle to get concentrate feeding right.

"In winter I want to be at the norm, and in the summer I allow myself to exceed it by 1 kilogram. I do that consciously in order to get a better balance between fat and protein. At the moment fat contents are down, and protein contents are up, and I don't really know why. In general, I think the grass is over-valued by both DELAR and the milk inspection. According to DELAR, I am 1.1 kilogram above the norm in the summer. The reference value for fat is 4.41 percent and we used to have 4.51 percent, which is a relic from our breeding policy. A few years ago the protein was difficult; now we are usually above 3.40 percent but a few years ago it used to be 3.28. Maybe it is just a matter of feeding. Now I give additional pulp nuts, and that pleases me well. In relation to protein, I think you shouldn't be feeding too much below the norms. Therefore I am not feeding the protein-poor standard-A nut of 150 VRE [an indicator for digestible protein, CL], but the a protein-rich nut of 300 VRE. That is why I am high with feeding costs, since DELAR doesn't correctly account for that. They calculate as if I pay the higher price for the standard-A nut, and then, of course, it always turns out too expensive. It is a pity that it is not possible to see the difference between the use of protein-poor and protein-rich concentrates. They start from the actual production, and then they calculate the norm, but maybe I would have 400 kilograms of milk less if I was feeding standard-A, who knows. It isn't really possible either to find out by comparing between farms, since situations are different. Also, it doesn't help much to vary between the years on your own farm, for you don't really know where changes should be attributed to; there are so many factors that play a role, and they can differ over the years as well, for example, the weather.

It is a good thing that in the calculations for DELAR norms they start from the farm itself, and not from some sort of average, because that wouldn't be of use at all."

In addition to the specifications pleaded for in the previous quote, there are others as well:

"They should split up the concentrates fed to the cows and the young cattle, so that it is known exactly what the cows get."

More than others, cowmen claim that the feeding costs should be at the norm (CM:59% versus MG:50%, TF:46%, PF:46%, MM:14% and FF:38%), and the same holds for concentrate feeding in both the grazing period (CM:55% versus MG:40%, TF:46%, PF:46%, MM:29% and FF:50%) and the stable period (CM:82% versus MG:60%, TF:62%, PF:67%, MM:57% and FF:50%). However, given the fact that they -quite deliberately- considerably exceed the norms for feeding costs, these goals must be interpreted -at least partly- in terms of wishful thinking and/or social desirability.

"You should never feed below the norms; it is not good to punish a cow for her production. According to DELAR a cow that produces 40 kilograms daily should be on zero during the summer, but you can't do that to such cows."

A relatively large number of cowmen indicate that having norms for mowing percentage (CM:47% versus MG:30%, TF:38%, PF:46%, MM:14% and FF:50%), costs on milk products for calves (CM:41% versus MG:10%, TF:23%, PF:13%, MM:0% and FF:20%) and expulsion percentage for milking cows (CM:61% versus MG:30%, TF:15%, PF:42%, MM:33% and FF:25%) do not make much sense. Similarly they argue more than several other styles that young cattle density should be higher than the norm (CM:39% versus MG:40%, TF:15%, PF:29%, MM:17% and FF:38%). These goals seem to be closely connected with the particularities of the Cowmen's strategy; in order to be able to properly select cows on milk yields, one needs to keep a lot of young animals (and consequently have higher costs in feeding them). Cows that do not live up to the high standards of cowmen are being expulsed, which therefore makes the expulsion percentage a parameter that is hard to influence. Like the multiple goalers -who also define their goals and strategies predominantly in technical terms- cowmen do not seem to be particularly interested in more economic DELAR norms.

In terms of their eventual results cowmen are characterized by relatively high (and in most cases the highest) feed & fodder costs right down the line (i.e. feeding costs per milking cow, concentrate feeding in both the stable and grazing period, fodder costs per milking cow, etc.). The high feed & fodder costs are -as a result of very high milk yields and high prices for milk (due to favourable fat and protein contents)- accompanied by high revenues per cow, and even by above average revenues minus feed & fodder costs per cow and per hectare. Furthermore (and as expected), these farms are characterized by a very high expulsion percentage for milking cows, and the lowest turnover and accretion per milking cow (due to low prices for calves, which -as a consequence of breeding practices- are not much good for fattening). Calf-mortality is relatively low, and the use of fertilizer is high. The variation in fodder costs per milking cow turns out to be remarkably high (see appendix 1 for details). This indicates that some cowmen are not only prepared to buy a lot of concentrates, but also a fair amount of roughage, whereas others apparently sell quite a bit of roughage. This phenomenon may be related to a differentiation that is suggested in Roep et al. (1991:72) between, on the one hand, cowmen that have 'green fingers' and, on the other hand, 'top-breeders' or 'fanatical cowmen'. The former tend to be more oriented towards self-sufficiency and (therefore) fine-tuning in fodder production. The latter are primarily geared towards pushing milk yields as high as possible, since high milking lists are a crucial prerequisite if one wishes to sell young cows or heifers at high prices.

The deviations from the DELAR norms show roughly the same picture. The cowmen are characterized by high deviations for concentrate feeding in the grazing period, fodder costs per milking cow, feeding costs per milking cow, total feed & fodder costs per milking cow, feed & fodder costs per 100 kilograms of milk, and additional feed & fodder (expressed in kilo-VEM) per hectare of grazing land. All these norms are exceeded quite considerably. Furthermore, the revenues minus feed & fodder costs per hectare and per cow are far below the norms; the same holds for turnover and accretion. When measured in absolute terms, the deviation from the norm for fodder costs per milking cow becomes -due to earlier discussed variation- even more pronounced. The same holds for additional feed & fodder (expressed in kilo-VEM) per hectare of grazing land.

The Machinemen

With an average farm size of 22 hectares and 45 cows, the machinemen tend to have slightly larger farms than the cowmen, whereby their milk-quota (on average 272 tonnes) gravitate more towards those of the smaller sized thrifty farmer. More than half (four out of seven) of the machinemen have a mixed farm whereby in two cases (MM:29% versus MG:10%, TF:0%, PF:0%, CM:3% and FF:19%) a beef unit is included. Pure MRIJ breed cattle are used on 71 percent of the farms. Machinemen are on average 49 years of age.

The Machinemen aim at the production of 'mass' in a labour- extensive manner, whereby mechanization is an important practical link between these two goals. As is shown in Roep et al. (1991), the Machinemen are characterized by a fair amount of flexibility with regard to how 'mass' production is achieved and what it means. The production of 'mass' can be centred for example around the production of meat, or the production of milk. In any case, they tend to keep the highest number of milking cows per hectare. This high stocking density conflicts in part with their general wish to use roughage rather than concentrates, which is reflected in that they do not hesitate to buy additional fodder when needed (see also Roep et al., 1991). Like thrifty farmers, multiple goalers and cowmen, the machinemen find it more important to take care of cattle and pasture to perfection than to adjust optimally to the market (see figure 8.4). This may seem to contradict with both their focus on the reduction of labour and their 'entrepreneurial' flexibility in relation to various issues. Nevertheless, they seem less oriented towards the market than the fanatical farmers and the practical farmers in that their flexibility holds within the boundaries of their (technically defined) strategy of 'mass' production. Thereby 'taking care of animals and pasture to perfection' seems to be less projected on individual animals and/or fields, but rather on the coordination between 'pasture management' and 'stable management' at a higher level of abstraction, and with the view of balancing the two towards 'mass' production. In their orientation towards technology, however, they tend to be more outward-oriented than the thrifty farmers, multiple goalers and cowmen. Thus, in that respect they resemble the practical farmers and especially the fanatical farmers (see figure 8.4).

The machinemen tend to be in regular contact with extension workers. Although the latter positively evaluate the former's efficiency of stables and pasture, they indicate also that the machinemen's craftsmanship, entrepreneurship and management qualities leave much to be desired. The characterization of their farms as relatively 'unbalanced' probably needs to be understood in this context (see tables 8.8 and 8.9). The impression is that within the extension service -which has urged farmers for years both to cut back on machinery ownership and to take greater care of individual animals and fields- there is little appreciation for the roughish mode of working of the Machinemen.

> "The extension worker told me to draw up a scheme for fertilization, but well, I am not such an administrator. Still, it is because of DELAR that I spread less fertilizer now, or at least I am a bit more aware of it. It is not so much because I think of the environment; I think more about what is easier."

Nevertheless, extension workers apparently find that their large scale and highly mechanized way of operating might work in the long run (or at least provides a viable background for improvement), since they evaluate the machinemen's future prospects as quite reasonable (see table 8.10).

Although at least some machinemen tend to value the public extension service (see table 8.7), a relatively large number argues that -in general- they do not think that it is necessary to frequently ask for 'expert' advice (MM:43% versus MG:30%, TF:23%, PF:17%, CM:29% and FF:31%).

> "It is not that we are on the phone the whole day in order to ring the extension service. There are people that swear an oath on the extension service, but they aren't the best of farmers. You need to decide for yourself, and not follow the one or the other."

Still, extension workers are sometimes handy in that (unpopular) activities can be delegated to them.

> "For the feed rationing I do indeed consult the extension worker. On this farm, we tend to be a bit high on fat. Last year, I was feeding a special nut in order to bring it down, but I found that rather expensive. Before, I had tried to reduce it with residues from beer brewing, and last year with pulp as well. I put some effort in trying to replace concentrates with roughage and stuff like brewing residues and pulp; these things are cheap at the moment. The extension worker is calculating now what I can do best this year."

A relatively large percentage of machinemen participate in cattle study clubs (MM:29% versus MG:0%, TF:17%, PF:25%, CM:9% and FF:0%), but their participation in breeding study clubs (MM:14% versus MG:0%, TF:8%, PF:21%, CM:26% and FF:27%) and especially DELAR group meetings (MM:43% versus MG:60%, TF:50%, PF:63%, CM:56% and FF:73%) is relatively low. Apart from (cattle) study clubs, a relatively large number consider farmer magazines to be an important source of information and ideas. In contrast, subject matter specialists, the breeding society and especially DELAR group meetings and private extension workers are deemed less important in this respect. The same holds for colleagues, which seems somewhat contradictory to their apparent interest in cattle study clubs (see table 8.7). In the following I will touch on some other inconsistencies and contradictions as well. In part, these contradictions can be attributed to the low number of machinemen (only seven) among the DELAR participants in De Achterhoek. This causes idiosyncrasies to rather strongly influence averages and/or percentages. Nevertheless, it seems that variation, flexibility and seeming contradictions may also be characteristic of Machinemen (see also Roep et al., 1991).

DELAR-use

Getting an overview of important parameters has been a particularly strong argument for machinemen to start using DELAR.

> "We participate with average registration. You need to know *roughly* where you stand, and which cows are below or above is something that you can look at yourself."

Two of the seven machinemen have discontinued DELAR participation, and the rest of them intend to continue. More than others, machinemen indicate that they have not made important changes to the way they operate on the basis of DELAR (MM:57% versus MG:30%, TF:46%, PF:29%, CM:47% and FF:50%). Furthermore, relatively few machinemen confirm that they use DELAR in order to set goals for the next year (MM:57% versus MG:80%, TF:62%, PF:67%, CM:65% and FF:81%). Parallel to these indications of relatively 'limited' DELAR-use, a relatively high percentage of machinemen indicate that they have plans to buy a management computer (MM:71% versus MG:20%, TF:31%, PF:74%, CM:44% and FF:36%). This interest in computers, however, was hardly found during qualitative interviews.

> "I am not going to sit behind the computer; I'd rather sit on the tractor, that suits me better. The computer is a tool. DELAR is quite nice, but the whole administration behind it ..[sighs].. You have to do so many things; keeping accounts on manure and fertilization, DELAR, you name it. It is true that it helps to refresh the memory. (...) No, I am not going to expand the computer business on my farm, enough is enough. A nephew of mine can sit behind that gadget for hours, but I don't fancy that at all."

> "A management computer? Well, perhaps it is of some use, but you can't live on it. Those things are not able to decide. It always turns out differently. The computer may tell me that I have to go mowing today, but then it may just rain. If it is one week early, and nice weather, I may already go out and do the mowing. Maybe I'll get such a thing for the bookkeeping. My wife has done a course on that, but we are in no hurry."

Nevertheless, they also see arguments in favour of the use of an on-farm 'integral' MSS, even if they are sometimes related primarily to maintaining a 'grey-zone' around the farm (the creation of such zones has been discussed by Frouws & Van der Ploeg, 1988:33-55).

> "We will continue with DELAR for a while, although we should maybe think that over once again. Everything that you participate in can be used against you as well. *The more you register, the more they will hunt you.* Officially it is all secured, but if someone really wants to know something, he will get it anyway. *In that sense it is much better to have your own computer.* I think it is scary, you are being put in the computer as this, that or the other, even if it is sometimes not correct at all. Farmers are a vulnerable group, and our leaders aren't much good in getting things done."

So far none of the machinemen has actually bought a management computer. The impression, however, is that many have bought a device for the automated feeding of certain ratios to cows. Some of these devices provide management facilities as well.

> "When the feeding computer arrived, I have also started to put the cow calendar in the computer. Earlier on I had a manual gadget, and that was fine too, but this one suits me fine as well. Every week a print-out with attentions. Moreover, my mother keeps a record of things on the calendar too, so she points out to me as well where I have to look at."

Given the scale on which machinemen operate (and/or their intended scale enlargement, see Roep et al., 1991) and their roughish mode of working, one could perhaps say that 'integral' MSS might indeed suit them well, for they could serve as a tool to compensate for the lack of individual animal attention. Also, these technologies fit well with their orientation towards externally developed new technologies (see figure 8.4). At the same time, an 'integral' MSS can hardly be called a labour-saving technology. Maybe it is in the context of this problem that their apparently somewhat contradictory attitudes in this respect must be understood.

In addition to comparing with DELAR norms, machinemen have a special interest in comparing with other farms, whereby they are interested especially in comparing their results with: (a) averages of specific groups of farms; (b) farms that they are well acquainted with; and/or (c) farms that in their view have remarkably good results (see tables 8.13 and 8.14).

> "I highly value constructive criticisms of other farmers. How do they look at it, and how could one do things differently. It helps indeed with organizing the farm set-up. At first, I started with figuring out why we were higher on concentrates. Now I am working on veterinary costs, and I am also analyzing mechanization costs. (...) Discussing each other's data is stimulating too, and it prevents enterprise blindness."

Machinemen seem hardly interested in making comparisons with previous years (table 8.13), although it appeared elsewhere in the survey that the opportunity to follow results from year to year was a frequently mentioned reason for their participation in DELAR (see table 8.11). However, from the qualitative interviews it emerges that especially in relation to more technical parameters they have some interest in comparing with previous years.

> "For me group comparisons are indeed important, but we do have a very diverse group. There is one farmer with only 40 cows, but he has the best results. For me the most important thing is that there is an increase in results from year to year; then I don't have to think, and I am sure that I am on the right track."

> "Essential parameters are feeding per milking cow, Nitrogen use per hectare and turnover and accretion per milking cow. In order to judge those, you need to look at the norms, and to the results of the previous year."

Machinemen, but also others with a high degree of mechanization, are indeed interested to include machinery costs in DELAR. As one of them argues:

> "Due to the fragmentation of the farm, I make high costs for mechanization and transport. They are now working on the inclusion of contract work, veterinarian and mechanization into the DELAR cost calculations. If you only calculate the feed and fodder costs you can't really face the

mechanization costs. With fodder costs it is like this: if you buy fodder those costs have in fact been accounted for already, but not if you do it yourself, and then it looks as if you have it very cheaply. This is a major misrepresentation. So now they are going to do something about it. Something similar happens with maize chaffing; whether or not you have to calculate your own labour costs, for if the contractor does it you pay for them too. I admit that if you include all this, you are coming closer and closer to an enterprise-economic accounting system. At a certain point in time you need to choose whether you are going to refine the whole thing, or keep it more simple."

For the analysis of mechanization costs it is in fact obvious that one needs to compare with other farms, for if a machine has already been set aside or bought, then comparisons are indeed "a day after the fair".

"We have at one point considered to change over to only feeding maize. At the time we made a comparison with an almost identical farm that was only feeding concentrates and maize. It appeared that in comparison to that farm we still have about 100,000 guilders left for mechanization and labour, etc. Therefore it seems that we will remain as we are. I have also looked at what it would cost if we would turn all grass into silage; it turned out that we will have 30,000 guilders of extra costs and a lower VEM-value in the roughage."

Finally, machinemen find the comparisons with DELAR norms important, but the impression is that -even more than others (see also section 8.5)- they tend to have difficulties in interpreting them, not least because of the exclusion of machinery costs.

"Quite a few cost items are missing in DELAR. A lot of things have to be subtracted from the revenues per cow, such as mechanization costs and the veterinarian. But I can't really check whether or not the norms are correct; I don't know. The norm is not that important, but still you always get a shock when you see the print-out for the first time. My wife always tells me that I'd better stop, because what is the use of starting to think negatively. Still, I think it is good that one is confronted with certain matters."

Attitudes and position vis-à-vis DELAR norms
Despite the fact that the majority of machinemen indicate that they do not set goals on the basis of DELAR norms, they appear -when asked- quite able to accentuate certain aspects in relation to them. Relatively many of them strive to keep feed & fodder costs below the norm. This holds both for fodder costs per milking cow (MM:57% versus MG:10%, TF:46%, PF:46%, CM:21% and FF:31%), concentrate feeding in the stable period (MM:43% versus MG:40%, TF:23%, PF:25%, CM:12% and FF:44%), and feeding costs in general (MM:71% versus MG:40%, TF:54%, PF:42%, CM:35% and FF:63%). Costs on milk products for calves should, according to most machinemen, be just at the norm (MM:71% versus MG:40%, TF:62%, PF:67%, CM:38% and FF:47%). A female farmer (mother of a male machineman) who takes care of rearing calves argues:

"I do indeed aim at that norm of 38 kilograms of milk replacer. You won't succeed for every calf, but you have to try, I think. There are many farmers who give the calves regular milk, but that seems much too expensive to me. For a bag of milk replacer which provides 200 litres you pay 76 guilders, but for 200 litres of milk you can easily get 160 guilders. By the way, my son is a very bad accountant, you can write that down if you wish."

However, not all machinemen agree with this way of reasoning, whereby they explicitly refer to reasons of *comfort* or the preference for a *large number of cows*.

> "They argue that I should be feeding more milk replacer. Last year I have milked 21,000 kilograms more than my quota allowed me, and the costs of that are around 8,000 guilders. *But I'd rather have one cow too many than to be one cow short.* By the way, for that amount of milk I am talking of almost three fat cows. The sweet milk goes to the calves, which is *easier* than milk-replacer, because you automatically have the right temperature. We give milk for four months, even if they could be weaned after three months. I have a remainder of roughage anyway, so I can handle three more cows."

> "According to DELAR we feed the calves too expensively. That is because we have changed over to only giving full milk. DELAR calculates the milk price for each litre, but of course that is not correct. You have to subtract the super-levy. Each year I exceed the quota by about 10,000 litres. The calves don't get diarrhoea, because we give them the milk of cows with lower fat and protein contents. *It is simply easier with regular milk.* There is no need to prepare it especially."

Connected to their emphasis on feeding roughage (and for some the application of in-house-summer-feeding, see Roep et al., 1991) many machinemen want the mowing percentage to be above the norm (MM:57% versus MG:60%, TF:23%, PF:38%, CM:29% and FF:31%). The same holds for turnover and accretion (MM:71% versus MG:50%, TF:31%, PF:42%, CM:47% and FF:56%). A relatively large number label the more economic parameters as 'unimportant'. Feed & fodder costs per 100 kilograms of milk, for example, is considered 'unimportant' by 57 percent of the machinemen (versus MG:10%, TF:23%, PF:46%, CM:12% and FF:19%). For revenues minus feed & fodder costs for the enterprise this holds for 29 percent of the machinemen (versus MG:0%, TF:8%, PF:8%, CM:12% and FF:19%), and for revenues minus feed & fodder costs per hectare for 43 percent (versus MG:10%, TF:0%, PF:13%, CM:21% and FF:19%). Other parameters that tend to be deemed 'unimportant' are the expulsion percentage for milking cows (MM:57% versus MG:40%, TF:31%, PF:33%, CM:56% and FF:38%) and young cattle density (MM:71% versus MG:40%, TF:62%, PF:25%, CM:32% and FF:44%). Again, this can be understood from the strategic deliberations of the Machinemen. The existing number of hectares do not serve for guidance, and therefore the revenues minus feed & fodder costs per hectare do not either.

> "The revenues per hectare or per cow don't mean much to me; it always goes down, of course, when you get more land, and when you reduce cows the revenues per cow hopefully increase."

Furthermore, the strategy and mode of working of the machinemen inherently results in a high expulsion percentage, which means again that a lot of young cattle need to be kept (see also Roep et al., 1991), which is probably why these norms are of less relevance. Not unlike the multiple goalers and the cowmen, the machinemen seem to be less interested in economic parameters and norms. Again, this seems to be related to the fact that the machinemen define their goals and model of farming predominantly in technical terms.

In practice the results of the machinemen are characterized especially by -on average- the highest stocking densities, the lowest mowing percentage, and the lowest milk production per cow. Costs of milk products for calves are relatively high, as are calf mortality, expulsion percentage and the percentage of new (self-bred and/or bought-in) cows entering the herd.

Both total feed & fodder costs and feed costs per milking cow are -on average- very low for machinemen, which is caused by the lowest concentrate feeding in both the stable and the grazing period. Despite low feeding costs, the revenues minus feed & fodder costs per milking cow are still very low, which is caused by the lowest revenues per cow due to low milk yields and low selling prices for milk and cattle (especially calves).

The deviations of the DELAR norms are not too spectacular. Concentrate feeding during the grazing period (and in absolute terms during the stable period as well) remain close to the norms, and also norms for fodder costs are exceeded less by machinemen than by many others (except for multiple goalers). The mowing percentage and turnover and accretion per milking cow remain far below the norms. In terms of revenues minus feed & fodder costs machinemen do not have an extreme position. In all, this means that the machinemen are -except for turnover and accretion- doing quite well. As mentioned before, low turnover and accretion is caused by low selling prices for cattle, and especially calves. As a result of their way of operating the machinemen may have to sell a fair amount of worn-out cattle. Also, I have mentioned that some of them have beef cattle as well, which means in fact that -more than others- they tend to hold on to the male calves. In order to calculate the value of 'accretion', i.e. the young cattle that are kept, DELAR uses the average value of calves that have been sold. Thus, when many male calves (which tend to be dearer than female calves) are kept, there may occur a negative bias in the calculation of turnover and accretion. The lower mowing percentage remains -especially given the indication that machinemen would like to be above the norm in this respect- somewhat puzzling. It may be that their high stocking density does not allow for too frequent mowing and/or that they -on average- tend to buy more fodder than others. The latter certainly holds for some machinemen, but on average their fodder costs are in fact close to the overall average.

Nevertheless, apart from the surprisingly low mowing percentage, these results and norm deviations clearly reflect the strategy of the machinemen and the goals that they have formulated vis-à-vis the DELAR norms.

The Fanatical Farmer

The fanatical farmers (on average 49 years of age) have by far the largest scale of operation (on average 28 hectares, 58 milking cows and milk-quota of 369 tonnes). Fifty-six percent (56%) of them have a mixed farm, on which -like the machinemen- a relatively large number (FF:19% versus MG:10%, TF:0%, PF:0%, CM:3% and MM:29%) have a beef unit with on average 113 cattle (against 28 for the machinemen). In 1986, already 94 percent (versus MG:60%, TF:85%, PF:83%, CM:79% and MM:86%) had a free-range slatted shed for the milking cows, many of which have Friesian-Holstein and/or Holstein-Friesian blood (only 44% use pure MRIJ cattle, versus MG:70%, TF:92%, PF:50%, CM:44% and MM:71%). In 1986, a relatively large number were practising in-house-summer-feeding (FF:50% versus MG:20%, TF:38%, PF:58%, CM:38% and MM:29%).

The Fanatical Farmer is oriented towards ongoing expansion, and maintaining a competitive advantage over others. Thereby they are guided primarily by external technological models, rather than by the existing farming practices and experiences (see figure 8.4). The Fanatical Farmers' external orientation is further expressed in their attitude towards the market (see figure 8.4), and also in the way they deal with DELAR. Thereby, the type of comparisons that the fanatical farmers tend to make is most eye-catching.

As I have summarized in tables 8.8 to 8.10, the farm organization, personal qualities and future prospects of the fanatical farmers are evaluated in an extremely positive manner by extension workers. It seems, however, that the relation between fanatical farmers and extension workers is -in a way- not reciprocal, since, when compared with other farmers, a considerable number of fanatical farmers indicate that the public extension service is not so important if it comes to providing new ideas and information (see table 8.7).

> "Of course we consult the extension service in case of *large scale* changes such as building new stables, but we do not count ourselves among those who continually call the extension service in order to ask whether or not it is the right moment to spread fertilizer."

Despite their orientation towards external models, they like to keep control over things themselves. Moreover, it seems that they sometimes have the feeling that extension workers come in order to *get* rather than to *bring* information. Thereby, the fanatical farmers confirm my speculation (see section 8.3) that their intensive contact with extension workers (see table 8.6) is not always based on *their own* initiative.

> "The data I discuss with my wife, not with the extension worker. One shouldn't let others rap you over the knuckles all the time. The feed industries offer farm supervision in combination with a management system. *That way they gain too much insight; they come by every month, calculate figures and then tell you how to do things.* In this manner it is them that are in control, and I am only left with the work. That is no good to me, and that is why I have bought my own management system. *It keeps me independent.* Figures and data are indeed important. Figures can prove that things are wrong. You need tools, and DELAR is a nice tool for retrospective evaluation. If something has gone wrong, you need data. I find it interesting and useful, but it shouldn't end up with the situation that someone else is telling you what to do and what not to do with the help of your own data."

With the exception of (private) extension workers, the fanatical farmers have a relatively strong interest in a wide variety of sources (see table 8.7). A relatively large number of them are members of a breeding study club (FF:27% versus MG:0%, TF:8%, PF:21%, CM:26% and MM:14%), and/or participate in the DELAR group meetings (FF:73% versus MG:60%, TF:50%, PF:63%, CM:56% and MM:43%). None (0%) of them participates in a cattle study club; such study clubs seem to be primarily the domain of practical farmers (25%), machinemen (29%) and thrifty farmers (17%). Like the practical farmers, it seems that the fanatical farmers widely orient themselves, which coincides seamlessly with their attention for external technological models[23].

DELAR-use

Fanatical farmers -like many others- have started to use DELAR primarily in the expectation to improve enterprise results and to get an overview of the farm. Of the five fanatical farmers (31%) who have discontinued their participation, two indicated that the procurement of an 'integral' MSS and PC was one of the reasons to do so. In total, three fanatical farmers (FF:19% versus MG:0%, TF:0%, PF:4% (n=1), CM:3% (n=1) and MM:0%) have already bought a management computer, whereas an additional five (36%) indicate that they intend to do so (versus MG:20%, TF:31%, PF:74%, CM:44% and MM:71%). As an important reason for buying such a system, it is mentioned that DELAR alone does not provide sufficient information to intervene in the course of the year. DELAR is too much a "retrospective evaluation", whereby one is "already one year farther" when one finally gets the results.

> "Thus, I can't directly mention changes that we have made on the basis of DELAR data. The rate of birth and mortality do have my attention of course, but when you get the DELAR print-out the year is already over. I have just bought a management package, and that is in the process of being installed. The advantage of such a program is that you get topical figures, so that bottlenecks are identified in a timely fashion, and fast adaptation is possible."

> "Towards the end of 1986, I have bought a management computer. At first, I only had COMRU, the cattle registration program of CEBECO. Later, a pasture calendar was added, and as from March this year a program for bookkeeping. I will continue with DELAR for one more year, and then I have it all organized myself. Computers are a big hobby of mine, and an expensive hobby too, I must add immediately. Especially the programs are expensive. Still, I think it will pay back in the end, even if that is hard to prove. In the beginning I had my doubts, but now I see that it saves a lot of time especially, for example, for doing accounts. *If you want to have data, you have them much more readily available, which is why you can take faster decisions*. That time is also worth something, of course."

In relation to this, fanatical farmers more than others agree (wholly and/or partly) that DELAR should provide monthly overviews (FF:50% versus MG:40%, TF:30%, PF:34%, CM:32% and MM:29%). By means of buying management computers, fanatical farmers seem also to anticipate purposefully (expected) future developments, for they do not only use arguments related to the contents of management computers, but they also mention grounds that relate to perceived competitive advantages, which might help them to win (or survive) the 'battle for the future' (see Roep et al., 1991).

> "I have my own computer with a management program, which involves everything that has to do with the cattle; coupling of milk and concentrate feeding, attention lists, etc. It pleases me well. I started because of my interest in it -it is a bit of a hobby- but I also think that those things *have the future*. Now, we need to get rid of the bad cows first, and *in this manner I really think it is the future*.

Like the Practical Farmer, the Fanatical Farmer seems to not only enjoy working with figures, but also have an urgent need for them, for the degrees of freedom for organizing the farm are -in absence of a clear technically defined model of farming- much larger than in case of the Cowmen, Multiple Goalers and Machinemen. A further similarity between the practical farmers and the fanatical farmers is that they more than others (except for multiple goalers) agree with the statement that 'one learns most from DELAR from collecting data and filling up the record-book'. Eighty-eight percent (88%) of the fanatical farmers wholly and/or partly agree with this statement (versus MG:90%, TF:54%, PF:79%, CM:61% and MM:43%), which may indicate their conscious way of dealing with figures. This may also be reflected in the fact that particularly fanatical farmers are aware that -in the past- they have made mistakes in filling up the record-book, so that results became less reliable (especially for others) (FF:56% versus MG:30%, TF:31%, PF:37%, CM:24% and

MM:43%)[24]. It is interesting to note in this context that -when others make mistakes- the fanatical farmers are not always convinced that these were made in good faith. In the qualitative interviews it were particularly Fanatical Farmers who expressed a certain amount of distrust, which is illustrative of their competitive attitude.

> "There are some farmers of whom I have the impression that they write down a lower feeding of concentrates than they really give, simply because they would like to emerge as the better farmers. Some people turn it into a competition, and don't write everything down."

> "The norms are fine, I have no doubt about that. I do have my doubts, however, whether farmers are honest in filling up the book."

Fanatical farmers have a very clear preference for comparing with DELAR norms. Comparing with previous years is of some importance as well, but they show little interest in comparing with others (see table 8.13).

> "I am too busy for that. There are more important things than discussing the data with other farmers."

> "DELAR is a check on how you are doing, and thus it is especially the information from one's own farm, one's results vis-à-vis the norms, that are most important. *It is incomparable to other farms anyway*.

The norms are of considerable importance to the Fanatical Farmers. They do not always agree with them, but even then they do not put them aside as easily as Practical Farmers do.

> "You assume that the norm is correct, but on the other hand you think that you know better. In the back of your mind you always reckon with it. And even if you think you know better, it needn't always be. Especially in study clubs you are at times forced to change your mind."

With some exaggeration it can be argued that -in a way- the norms (supposedly embodying the latest scientific knowledge) are indeed the only beacons for comparison for the Fanatical Farmers. The past (and therefore comparing with previous years) isn't something that they can hold on to, since it is conceived as a state of affairs that is to be rapidly overcome; as a temporary stage that is always in need of quite drastic changes. Other farms are no measure either, for these are the competitors who need to be left behind.

> The most important thing is the deviation from the norm. Comparing with others doesn't make much sense; there is not much that you can do with that. The circumstances are so different, that figures are bound to be different. Also the demands of the farmer himself can differ. For dealing with the norms you need to make assumptions, for you can have prolonged discussions with other farmers about how the norms should be calculated. (...) *You try to get above the norms, that is what I strive at.*"

If fanatical farmers do compare their own figures with those of others, they do so primarily with farms with which they are well acquainted and/or with farms which have remarkably good results (see table 8.14). Thus, they are rather selective. Their relatively frequent participation in study clubs and DELAR group meetings coincides well with their tendency to widely orient themselves. Moreover, some fanatical farmers do not only participate in order to learn themselves, but also because extension workers have asked them to be present as '*example farms*' from which others can supposedly learn.

> "We used to be a LEI study farm. That was a group of people with new stables in the beginning of the seventies. The LEI wanted to study the results and data of those farms, also with a view of extension to other farms. During that period, we have also come in contact with DELAR. The extension service asked us to consider participation in order to compare our results with those of others. That was in 1972."

Thereby, Fanatical Farmers seem to be less tolerant and flexible in relation to other modes of farming than the Practical Farmers, who also participate frequently in study clubs.

> "*In my group there is no one that I could really compare myself with*; thus, I always look for each parameter what the score of others is. You can also learn from the mistakes of others, and *bad farms* may have good sides as well from which you can learn."

Given the Practical Farmers' interest in and sympathy for different ways of operating, they do not so easily use terms such as *bad farms* and/or *bad farmers*.

Attitudes and position vis-à-vis DELAR norms

From the qualitative interviews it emerges that Fanatical Farmers are especially interested in the more economic parameters and norms. Again this is connected with the lack of a clearly defined technical model for the organization of the farm, which -as the following quote illustrates- sometimes leads them to engage in somewhat radical experiments as well.

> "To me revenues minus feed & fodder costs are the most important DELAR parameters. From there you have to look at how the other figures arise. Three or four years ago I have been feeding an awful lot of soy. The milk was squirting out, but it appeared to be too expensive. I gave a fixed quantity per cow, which made production increase, but against too high a cost price. If you wouldn't have the DELAR data you would continue to do so."

> "Ten years ago we started to use DELAR. The extension worker put us in contact with it. We started in order to confront costs and revenues, and to see where exactly the costs and revenues are located. You can't really find that out with ordinary bookkeeping."

More than others, fanatical farmers want revenues minus feed & fodder costs per cow (FF:44% versus MG:30%, TF:38%, PF:33%, CM:32% and MM:29%), per hectare (FF:40% versus MG:30%, TF:23%, PF:21%, CM:29% and MM:33%), and for the farm as a whole (FF:47% versus MG:40%, TF:46%, PF:13%, CM:35% and MM:14%) to be right at the norm[25]. This is expressed in the following statement, which also underlines once more their somewhat competitive attitude.

> "Per hectare we are never the best, but per cow we can indeed be the best. Thus, the most important parameters are indeed the revenues minus feed & fodder costs per cow and per hectare."

Moreover, relatively many fanatical farmers wish to keep feed costs per milking cow below the norm (FF:63% versus MG:40%, TF:54%, PF:42%, CM:35% and MM:71%), whereby - in comparison with others- they particularly emphasize that concentrate feeding in the stable period is to be lower than the norm (FF:44% versus MG:40%, TF:23%, PF:25%, CM:12% and MM:43%).

> "Among the parameters, I find the revenues minus feed & fodder costs per cow, of course, the most important. Furthermore, it is easy to regulate feed costs, so you keep an eye on that as well. I am always a bit too high on feed costs, but I try to bring it down. Now I have a remainder of roughage, and I try to get them to eat as much roughage as possible in order to cut back on concentrates. With the computer you can compose different rations, and it is between those that you start comparing."

According to many fanatical farmers, it does not make much sense to have a norm for mowing percentage (FF:50% versus MG:30%, TF:38%, PF:46%, CM:47% and MM:14%). As is the case with particularly multiple goalers and cowmen, they frequently argue that young cattle density can be above the norm (FF:38% versus MG:40%, TF:15%, PF:29%, CM:39% and MM:17%); not only because of the reasons mentioned by multiple goalers and cowmen, but also in order to be prepared for the future.

> "What is o.k., is o.k., and some other things are hard to change, but DELAR makes you to really pay attention. If you exceed a norm, if you are too high, you really watch out, and try to do something about it, even if sometimes you can't control everything. And if you are a bit too high, you often have your own reasons for it as well. I am always too high on young replacement cattle, but I have my reasons. A fast replacement, *and I want to be prepared for the free market.*

Looking at the actual results of the fanatical farmers one sees that -on average- they feed quite a bit of concentrates in both the stable and the grazing period. In total, however, both feed and fodder costs are quite average. Thereby, they manage to reach the second highest (after the thrifty farmers) revenues minus feed & fodder costs per cow, which is achieved with the help of high milk yields (second to the cowmen), a fairly high turnover and accretion per milking cow, and a high selling price for milk. Furthermore, the fanatical farmers use -on average- a relatively large amount of fertilizer (Nitrogen). In the reproductive domain the fanatical farmers are characterized by the lowest expulsion percentage for milking cows (and consequently a low number of new cows entering the herd), and -nevertheless- the highest average young cattle density (probably related to the frequent holding on to young animals for beef farming purposes). The birth rate is rather low, and calf mortality is high. Finally, fanatical farmers have the highest costs of milk products for calves.

When looking at the deviations from the norms a rather striking picture emerges. In terms of the relative norm-deviations the fanatical farmers only distinguish themselves with the highest deviation for concentrate feeding in the grazing period (a norm that is exceeded by virtually all farmers). In absolute terms, however, the fanatical farmers have high deviations in relation to ten of the twelve parameters for which norm deviations were calculated (see appendix 1); for four parameters they have the highest deviation from the norm, and for an additional six parameters the second highest. These parameters include concentrate feeding in the grazing period, additional feed & fodder (expressed as kilo-VEM) per hectare of grazing land, price per kilo-VEM of bought-in roughage, fodder costs per milking cow, mowing percentage, revenues minus feed & fodder costs per hectare and per cow, feed & fodder costs per 100 kilograms of milk, total feed & fodder costs, and turnover and accretion per milking cow. This points to relatively high deviations from the norm in both a negative and a positive sense for a large number of parameters; i.e. a wide range above and below zero. In this respect the fanatical farmers distinguish themselves from other styles of farming. Most of the high deviations from the norms discussed so far had a rather clear direction (that is, they were systematically above or below the norm), which was mostly in line with style-specific strategic considerations. It is only in the case of the practical farmers that a similar phenomenon was demonstrated in relation to only one parameter; all other high absolute deviations are connected with high deviations in relative terms as well, and thus with a rather clear direction.

It seems that the lack of a clear technically defined model for farm organization, leads - in case of the fanatical farmers- to a large variation therein. In case of the thrifty farmers and the practical farmers too, I have shown that such a model was lacking. However, in contrast to the Fanatical Farmers, the latter seem to depart from an economic model in which the *present farm organization* is a central prerequisite and starting point for future development. Similarly, it seems that the weighing of costs and benefits is -in case of the Thrifty Farmer and the Practical Farmer- more oriented towards achieving an income here-and-now, whereas in case of the Fanatical Farmer it is more oriented towards ensuring the future competitive power of the farm. Thus, Thrifty Farmers and Practical Farmers can be associated with a more gradual and consistent pattern of development, whereas the Fanatical Farmers are characterized by a greater variation of development paths, and a less gradual mode of development; i.e. 'development by leaps' (a term which was first used by Roep, 1988).

In all, it remains quite paradoxical that the style of farming in relation to which extension workers express the least positive judgements (see tables 8.8 to 8.10), is characterized by results that fit best with the DELAR model, whereas those that are evaluated most favourably do in fact deviate most as well.

A qualitative thematic summary of differences and similarities in DELAR-use

I have shown that differences emerge especially with regard to: (a) the parameters and norms that different farmers focus on; (b) the goals that are formulated vis-à-vis the norms; and (c) the type of comparisons that are made on the basis of DELAR. Thereby, it often appeared that there are plausible connections between the specific ways of dealing with DELAR, the different knowledge networks that farmers are part of, and the specific strategic notions that seem to underlie the different farming styles.

Parameters and the relations between them

It seems that the parameters and norms that farmers focus on are clearly connected to the *nature* of the strategic considerations and goals that can be associated with the different styles of farming. The strategies of the Multiple Goalers (self-sufficiency through low external input), the Cowmen (reaching a high milk yield per cow through labour-intensive practices) and the Machinemen (mass production through labour-extensive practices) can be easily translated into rather straightforward goals at the *technical* level. In relation to this, these farmers orient themselves especially towards specific technical parameters and norms (see also section 8.3 and table 8.15). From the strategic considerations of the Thrifty Farmers (monetary balance), the Practical Farmers (practical balance, especially in labour organization) and the Fanatical Farmers (gaining a competitive advantage over others) it is less easy to identify a clear-cut technically defined logic, which runs parallel to their stronger focus on *economic* parameters and norms. Earlier on, I have connected this technical versus economic orientation dimension with the third discriminant function (see table 8.3). In line with the magnitude of the discriminant function coefficients, my elaborations have shown that indeed the Multiple Goalers and the Cowmen have the most clearly demarcated technical orientation, while the Machinemen tend to be more flexible in this respect. Similarly, the Practical Farmers are most outspoken in their economic orientation, while the competitive considerations of the Fanatical Farmers have both a technological and an economic dimension (whereby economic consideration must sometimes give way to technological ones). For the Thrifty Farmers the interest in economic parameters arises from monetary (rather than strictly economic) concerns, and is accompanied with goals at the technical level which resemble those of Multiple Goalers.

Naturally, Thrifty Farmers, Practical Farmers and Fanatical Farmers too have technically defined goals, but these seem to be *derived* from monetary and/or economic considerations; thus, they are -when compared to those found among farmers belonging to the other three styles of farming- of secondary importance and less fixed (or 'dogmatically' adhered to). The opposite holds for the Multiple Goalers, Cowmen and Machinemen. They start from technical goals, which -broadly speaking- shape their way of operating; although the financial and economic consequences of their practices cannot be ignored, they are -to a certain extent- a derivative rather than of guiding importance.

Moreover, it can be concluded that not only the interest in particular parameters and norms varies between the styles of farming, but also that there are differences with regard to the ways farmers reason about and interrelate these parameters and norms. The Cowmen, for example, tend to consider feeding costs as a parameter for which the result follows logically from the required milk yields per cow, whereas in -in the eyes of the Multiple Goalers- cause and effect should be looked at in a radically different fashion. In fact, the latter would argue the exact opposite, namely that milk yields per cow follow logically from the required (that is, acceptable) quantity of feed & fodder that can be externally bought. More in general, the foregoing can be summarized by stating that between the various styles of farming, different -mostly implicit- *causal models* (Bolhuis & Van der Ploeg, 1985) are used for reasoning and thinking about the farm. It must be stressed that I do not wish to suggest that all farmers do indeed reason in terms of (be it different) parameters, norms, goals and relationships of cause and effect. The priorities, interrelations and goals that farmers have formulated in relation to parameters and norms, were, of course, responses to questions that were asked by the researchers. Necessarily, these questions imply a certain limitation of the scope for discussion (even if our methodology allowed for an influence of farmers in the area of discourse). In fact, farmers were *asked* to reason about their farms in terms of the parameters and norms included in the DELAR model, but it does not necessarily follow that they would do so outside an interview context as well. The reason to speak of 'causal models' at this point, is only to make clear that, even if farmers would think about their farms in terms of parameters, norms, cause-effect relationships, etc., the DELAR model is *but one* causal model, and that this study shows that -in practice- wholly or partly different models are used as well. Given the variety of causal models used, it is hardly surprising that the DELAR model fits some styles better than others.

Dealing with the DELAR norms
I have shown that the styles of farming are connected with differences in the interest that farmers express in the various opportunities for comparison provided by DELAR. Nevertheless, within each style comparing with the norms is -at least as far as *my* quantitative evidence is concerned[26]- considered as the most interesting opportunity (even if the percentage of farmers who rank it as the most interesting type of comparison ranges from 42 percent to 81 percent, see table 8.13). However, it has emerged that this does not at all mean that these norms are actually aimed for. On the basis of the underlying logic connected with each style, farmers are frequently satisfied with, or explicitly aim for, particular deviations from the norms. In many cases, these aimed-for and/or allowed-for deviations from the norms could not only be *readily interpreted* in the context of style-specific strategic considerations, but were also *reflected* in the actual results vis-à-vis others and/or the norms. It can be concluded, therefore, that the extent to which the DELAR norms are considered to actually *be* normative is often limited. As one farmer put it:

> "The norms are only used as a *handle*, in order to detect where things may be wrong. We have never really worried about whether or not the norms are correct or not."

In other words, the norms are used as a type of *agenda*, which helps -from a different perspective- to think about the farm, and as *points of reference* for the formulation of goals and the evaluation of performance. In the light of the (normatively based) strategic diversity that I encountered in the field, and the actual use of the DELAR norms, it can be argued that the use of the term '*norm*' is in fact misleading and confusing; it may indeed be more appropriate to speak of a *reference-value*. It must be noted that this 'agenda-effect' may not only hold for the DELAR norms, but also for figures in general. This emerges from the fact that 70 percent of all farmers either wholly (28%) or partly (42%) agree with the statement that 'one learns most from DELAR from having to collect data and fill them up in the record-book' (MG:90%, TF:54%, PF:79%, CM:61%, MM:43%, FF:88%).

That many farmers are not very strict in dealing with the normative model incorporated in DELAR, appears as well from other details that I have not discussed so far. For the calculation of DELAR norms a series of parameters (including Nitrogen use) are treated as given (see section 8.1). Thus, it is impossible for DELAR to calculate a norm for Nitrogen use. Nevertheless, a considerable number of farmers (belonging to different styles of farming) frequently refer to the existence of such a norm in DELAR.

> "In our view, the DELAR norms for Nitrogen use are too low. We don't agree with them. DELAR puts the norm at 400 kilograms, but last year we had 420 kilograms. (...) It has been even higher, but we too have become more conscious of the environment."

> "I don't know how they calculate that norm. Maybe they reckon 80 kilograms for every cut; that would be around the level that I reach. In spring I start with 100 kilograms of Nitrogen, and after that I give somewhat smaller quantities on six or seven occasions, that is better than putting out a lot on three or four occasions, because you have fewer losses that way. We have a mowing percentage of 300, and I could safely say that that is quite high, so I can do it this way."

"At the moment, I am at 300 kilograms of pure Nitrogen per hectare, and that is within the DELAR norm, but for a long time I have exceeded it."

Some farmers can even mention the exact value of what -in the context of the discussion- they considered to be the DELAR norm.

"Furthermore, I am always a bit too high on fertilizer, and I will try to bring that back. Last year I have strewn 491 kilograms of Nitrogen per hectare, whereas the norm was 456 kilograms. That is indeed very high, but that is also because you mow a lot, then it is allowed to be high."

"For Nitrogen use we are in kilograms just below the norm: 392 kilograms from artificial manure, and when the Nitrogen from organic manure is included we arrive at 486 kilograms of Nitrogen per hectare."

From these quotes, it emerges that farmers hardly differentiate between DELAR norms and norms that they are confronted with from other sources. At the same time it shows that they have not really fathomed the essence of the DELAR model. In section 8.5, I will come back to the interpretability of the DELAR parameters and norms.

Comparing with others and/or previous years
At first sight -and somewhat surprisingly- the different priorities between the styles with regard to making comparisons with others and/or with previous years (see table 8.13), do not seem to be systematically related to either the importance attached to colleagues as a source of information (see table 8.7) or the valuation of one's own insights and experience (i.e. orientation towards technology, see figure 8.4). However, the different convictions and practices in this respect can be well interpreted against the background of specific characteristics associated with different styles of farming. Thereby, it emerges that -especially in relation to comparing with others- there are important qualitative differences. When these differences are taken into account, it seems that there are indeed interrelations between the valuation of colleagues as an information source, and practices and priorities concerning comparing with others.

The Multiple Goalers and Practical Farmers find comparing with others relatively important, whereby by they -either informally or in the context of DELAR group meetings- prefer to make *contextual* comparisons. From this it emerges that they have a genuine interest in other farms and the ideas of colleagues, which is indeed confirmed and underlined in table 8.7. I have shown that this 'openness' can be well understood from their position and strategy. The Thrifty Farmers and Machinemen too indicate that they find comparing with others important (table 8.13), but they are particularly interested in *numerical* rather than contextual comparisons, which runs indeed parallel to a relatively limited valuation of colleagues as an information source (table 8.7). They have rather fixed ideas with respect to the way the farm is to be organized, but do want to know whether or not they are more or less *in line* with others. Both Cowmen and Fanatical Farmers, who find colleagues important sources of new ideas and information, show relatively little interest in comparisons with others on the basis of DELAR. The Cowmen have a crystal-clear idea of how the farm is to be organized, and DELAR parameters and norms are considered too unspecific for comparisons with others, this in contrast to data that can be exchanged in, for example, the breeding study clubs. Thus, the Cowmen too make numerical comparisons when they compare on the basis of DELAR, whereby they tend to have relatively pronounced selection criteria. The Fanatical Farmers, then, are even more selective than the Cowmen, whereby they emphasize the incomparability of their farms with those of the great majority of farmers. In fact, many farmers of all styles (except for the Fanatical Farmers who seem to look for particular individual farms) stress the importance of comparing with the averages of *specific groups* of farmers (see table 8.14). Thereby, the specific groups that are selected do not only vary per farming style, but also according to the nature of the problems that are dealt with at a particular point in time.

The interest in comparing with previous years can -to a large extent- be associated with the relative valuation of one's own insights and experience (i.e. orientation towards technology, see figure 8.4). The Multiple Goalers, Practical Farmers and Cowmen -relatively speaking- highly value both their own insights and experiences *and* comparisons with previous years. By means of such comparisons, these farmers seem indeed to evaluate and further develop their own insights and experience. The Machinemen and Fanatical Farmers are more externally oriented, and therefore seem to pay less attention to comparisons with previous years; i.e. they are slightly less geared to developing their own expertise and/or craftsmanship. The Thrifty Farmers are an exception in this respect; despite the fact that they highly value their own insights and experience, they show little interest for comparisons with previous years. There are some indications that they tend to be less oriented towards changing and adapting the organization of the farm from year to year.

Discontinuation of DELAR-use and the need for on-farm 'integral' MSS
There are various considerations which have led farmers to start using DELAR. Many farmers had expected to improve enterprise results; be it through getting an overview of important parameters, through the examination of results from year to year, and/or comparisons with other farms (see table 8.11). The extension service has played an important role in stimulating DELAR-use as well. In many cases, farmers have decided to start using DELAR after getting extension service advice on the building of new housing facilities for milking cows, or other important investments. In some cases the impression was that farmers started to participate in order to please the extension worker and/or as a compensation for the substantial efforts made by the latter in providing advice.

Although I have detected meaningful differences in the way DELAR is used, it is clear that in any case DELAR is used for *ex-post evaluations*. Results are evaluated against either one's own goals and principles, the performance of others, the results of previous years and/or the norms that are developed by agricultural research and extension organizations. In such evaluations, DELAR parameters and norms tend to be used as *points of reference* and *agenda setters*. The quite substantial discontinuation percentage (in total 27% between 1986 and 1989; see table 8.12) indicates that many people only temporarily participate in such an ex-post evaluation. The most important reason to discontinue participation was the feeling that DELAR did no longer provide new information after a while. Thus, it is clear that -especially among Multiple Goalers and Thrifty Farmers- the introduction of radically new practices (as connected with, for example, the building of free-range cattle housing facilities) leads to a *temporary need* of such evaluations. Apparently, farmers try to regain grip on their farms, and when -after a few years- control has been restored, DELAR adds less and less to what they already know.

In contrast, particularly the Practical Farmers and the Fanatical Farmers tend to engage more often in such radical changes, which results in a *continuous need* for ex-post evaluation. In the case of the Practical Farmers this need results in the prolonged use of DELAR, whereas the Fanatical Farmers increasingly change over to an on-farm 'integral' MSS. With the help of these MSS the *time interval* between two evaluations can -at least for some parameters- be reduced considerably, which is of particular use to Practical and Fanatical Farmers. In addition, these types of farmers seem -more than others- to enjoy working with figures and numbers. Similarly, they seem to think about their farms in more abstract terms, such as the more economic parameters and norms.

At this point, it is interesting to note that a later study in which I participated (Stolzenbach et al., 1993) indicates that the type of aggregated (technical and economic) parameters generated by DELAR, can be quite useful in providing structure to the use of on-farm 'integral' MSS. That is, the quality of 'integral' MSS-use can be improved by providing an agenda at a higher level of abstraction. Such an agenda helps to identify potential problems, and gives *direction* to a search for more concrete feedback within the MSS (e.g. on individual cows and/or more specific periods), by means of which the potential problem situation can be analyzed. Thus, as long as such aggregated overviews are not provided by on-farm 'integral' MSS, DELAR-like overviews may -even for Fanatical Farmers- have a role to play in improving the use of the latter.

The attractiveness of on-farm 'integral' MSS seems to be associated with the scale of operation as well. Within those styles of farming that presently operate a somewhat larger scale (that is, the fanatical farmers, practical farmers and machinemen, who are also most radical with respect to the assessment of required scale enlargement[27]) the interest in and/or actual possession of management computers is highest.

8.5 The use of DELAR in interactions between farmers and extension workers

In the previous sections I have focused on the independent use of DELAR by farmers, i.e. on the use of DELAR as an Extension Worker Replacing System (see section 7.3). However, in many instances DELAR plays a role in direct interactions between extension workers and farmers; i.e. it is a tool within and/or it gives rise to extension worker/farmer interactions. Since DELAR has been explicitly developed from an extension philosophy (see section 8.1), one could in those instances speak of DELAR as an Extension Worker Supporting (Feedback) System. In this section I will focus on the use of DELAR in the context of such extension worker/farmer interactions. First, I will introduce the activities that extension workers have developed in relation to DELAR. Subsequently, I will discuss some qualitative observations in relation to these.

DELAR-related activities

In the course of time, the public extension service in the Achterhoek has developed four DELAR-related activities: (1) providing written advice; (2) offering individual discussions and supervision; (3) organizing yearly DELAR group meetings; and (4) supervising DELAR study clubs.

My discussion of these activities is based on the 1990 situation; that is, after the formation of DLV (see section 8.1). Although essentially the same as those that existed before the privatization process, these activities are subject to greater central coordination in the new situation (e.g. in the form of guidelines for DELAR-use by extension workers)[28]. Even if there are regional differences in the way DLV teams deal with DELAR, the privatized DLV as a whole has a renewed interest in DELAR as a possible element in a wider package of farm supervision to which farmers can subscribe.

Written advice
Since time is lacking for an individual discussion with all participants, the DLV has started to send a written advice to all DELAR participants. As soon as a copy of a DELAR print-out arrives at the DLV office (if farmers consent, DLV is automatically provided with these copies by the accountancy bureaus), one of the extension workers generates a written advice of about one or two pages. Writing such an advice does not take too much time; one extension worker indicated that he needed about half an hour per advice (he had to prepare 80). In an accompanying letter, the farmers' attention is drawn to the opportunity to make an appointment for more elaborate individual discussion.

Individual discussions and supervision
When requested by participants, an extension worker pays a visit to the farm in order to discuss the print-out and elucidate the written advice. For new participants, DLV takes the initiative to such individual discussions, which can last for a few hours. It was estimated by extension staff in De Achterhoek, that in 1990 such meetings were held with between ten and fifteen percent of the about 300 DELAR participants for which they were responsible. In addition, the DELAR print-out can also play a role in regular individual extension worker/farmer interactions which are initiated in a different manner and for different purposes. Extension staff could not indicate how often parts of the DELAR print-out are discussed in this more indirect manner.

The yearly DELAR group meeting
DELAR participants who are not members of a DELAR study club, are invited to attend a group meeting on an annual basis. These meetings are usually held in a cafe/restaurant, and for each meeting between 10 and 25 farmers are invited. Attendance seems to vary considerably. These meetings centre around the results of participating farms in the region. To this end, the accountancy bureaus provide comparative farm overviews. In most yearly group meetings the results remain anonymous, and group composition may change from year to year. In 1989, 44 out of the 104 respondents did not participate in group meetings of any kind, and 22 indicated that they met only once a year. The remaining 38 farmers met more often; in these cases I speak of a DELAR study club.

DELAR study clubs
In the course of time, some DELAR group meetings have evolved into DELAR study clubs. In these study clubs, a fixed group of participants meets several times a year in order to discuss their farms on the basis of DELAR. Attendance is often high. Most groups consist of eight to twelve participants. Roughly half of the 38 respondents who are a member of such a study club indicate that they meet two or three times a year, whereas the other half

meets five or six times a year. Part of these meetings are combined with a visit to a specific farm, whereby the discussions centre around the results of that particular farm. In these study clubs anonymity is often lifted.

Until the privatization of the public extension service, farmers could make use of above mentioned services free of charge. After 1990, charges have been gradually introduced. Also, group-extension activities came -at least temporarily- under pressure[29].

Observations concerning DELAR-related activities and interactions

My observations in relation to the various types of DELAR-related activities and interactions revealed a number of similarities. Therefore, I will discuss them in a thematic fashion; only the observations in relation to written advice will be discussed separately.

Bottlenecks in giving written advice
In practice, the written advice consists of a brief summing up of eye-catching results vis-à-vis the norms and/or previous years. A farmer who carefully studies the DELAR print-out ought no doubt arrive at the same conclusions. Extension workers consider the written advice primarily as something that can help participants read the print-out. This is thought to be useful, since -according to extension workers- experience shows that some farmers have difficulty in reading the print-out. At the same time extension workers are unhappy to observe that some farmers now *only* use the written advice, and ignore the print-out itself.

The resort to summing up deviations from norms and previous years, seems to be related to the fact that -on the basis of figures alone- extension workers frequently find it difficult to give an advice that -as one of them says- "*cuts ice*". First, they have to be aware of mistakes in the print-out (I will come back to this), and they find it also rather difficult to place the figures in the right context, especially when they are unfamiliar with the farm (I will later return to this as well). As one extension worker put it "*you can really be beside the mark*", which is why he prefers to keep a low profile and/or be noncommittal in his written advice. At the social level too, extension workers have a certain fear of blundering, since farmers can be easily offended by written advice. They stress that each farmer, depending on the context, has his or her own "*directions for use*", and that it is difficult to anticipate this in a written advice. In their experience, some farmers easily regard a written advice as showing little insight, and/or (because of its superficiality) as an insult.

Group meetings and the influence of extension workers
Extension workers can have considerable influence on the emergence, course of events and character of group meetings. There were important differences between the three group meetings that I attended, even if in all cases they were meant to be the yearly discussion of regional results. In all cases, comparative farm overviews were provided, and the programme was prepared by the extension worker, who also chaired the meeting. In one case, the emphasis was on explaining the DELAR parameters and model on the basis of a print-out of an anonymous farm with rather 'extreme' results. In another case, the emphasis was on comparing the average results in the region with the average results of the whole province,

the filling up of the record-book, and various more general issues such as results from LEI research. In the third meeting, explicit attention was paid to the comparative farm overviews, and to the results of a particular anonymous farm. In relation to both themes, the extension worker paid a great deal of attention to provoking farmers' reactions, judgements and critique, whereby discussions among farmers were frequently allowed to continue. In this third meeting, attention was paid also to the sense and non-sense of 'integral' MSS.

In all, it seems that extension workers -in their design of group meetings- start from different goals and assumptions. It is of course difficult to evaluate which meeting was most 'appropriate' or 'according to the book'. Nevertheless, it was quite clear that farmer involvement and liveliness was highest in the third meeting.

The cruciality of the context
At all attended (individual and group) meetings (and also in relation to earlier discussed written advice) it became abundantly clear that it is impossible to draw conclusions and/or generate advice only on the basis of figures. For arriving at an adequate and shared interpretation of deviations from DELAR norms and/or previous years, it appears necessary to have additional context information. As emerges from this study (see section 8.4) a 'farming style' might be an important context-'variable', but apart from issues of strategy there are also a large number of very practical and down-to-earth difficulties in interpreting figures and deviations.

Box 8.3: **Some examples of practical problems for interpretation**

- Someone who has recently bought a few heifers which have just calved, will in that year immediately have a number of calves born per 100 cows which is below the norm.
- The fact that feed costs are exceeded may be caused by the fact that concentrates are bought from a firm which passes on the costs for 'free' services and extension in the prices for concentrates.
- When extra young cattle are kept on the farm, deviations from the norm for turnover and accretion per milking cow can be caused, since for the calculation of it, DELAR calculates as if these young animals have been sold at the average selling price for those that really went to the market, whereas -in practice- above-average cattle are kept.
- A farm can look badly on paper, but it is not clear in advance whether this is caused by conditions that are within reach of the farmer, or by -for example- the occurrence of a drought at a particular location.

For each deviation from a norm there are always several alternative interpretations, and the most adequate interpretation can rarely be derived only from the data available in DELAR. In fact, it appears that DELAR is not elaborate enough to correct for specific circumstances (let alone for particular styles of farming). Thus, it is not surprising that many of the discussions which emerge around DELAR have the character of *a search for the most adequate interpretation*, or -to put it differently- as an attempt to correct for shortcomings in the model. To the extent that such searching and correcting is educative and insightful, I would argue that it is a positive contribution to an extension process (DELAR as an EWSGS). However, in some cases these exercises can be rather time-consuming, confusing, irritating and unproductive as well (DELAR as an EWSDS, see section 7.3).

The complexity of the DELAR model

Even if -from the perspective described above- DELAR is not elaborate enough, it is at the same time already enormously complex. In fact, it is so complex that farmers and also extension workers sometimes have great difficulty to interpret the figures (even apart from problems related to putting them in the right context). In interactions with extension workers, farmers -especially when they deviate from the norms- ask very specific questions about how parameters and norms have been calculated.

> "My milk production increased by 200 kilograms per cow this year, and all other things have remained more or less the same; how can it be, then, that my norm for additionally bought kilo-VEMs per hectare has decreased by 600?"

> "How can it be that the Fertilization Advisory Program [BAP] allows me to spread 560 kilograms of Nitrogen, whereas DELAR tells me to put out only 418 kilograms?"

> "You tell me that I am too high on veterinary costs, but how exactly is that norm being calculated?"

Extension workers are often not capable of giving direct and precise answers to this type of questions, which does not always improve their credibility in the eyes of farmers. In some cases, extension workers had written documentation at hand from which questions could be answered. In other cases, questions were evaded, ignored, left unclarified, or send on to the IKC. Especially in group meetings, there seemed to be too little time to thoroughly address such questions as asked above. According to extension workers, it has occurred that, on the basis of farmers' questions, important mistakes in the DELAR model were uncovered. In the light of the foregoing, availability of documentation on calculation rules for extension workers seems important. Such documentation has been provided from 1984 onwards, but at the time of research (1990), available documentation was outdated, in part due to a major rewriting exercise carried out by the accountancy bureaus. Furthermore, extension workers could not readily access such documentation in actual practice. Even for IKC staff it appeared necessary (in 1990) to sometimes consult the accountancy bureaus or the original developers of (parts of) DELAR in effort to get precise information on calculation rules.

Mistakes in filling up the record-book

The interpretability of the DELAR print-out is not only hampered by contextuality problems, and lack of transparency, but also by the apparent fact that many mistakes are made when filling up the record-book. In all meetings attended, considerable mistakes came to light. Often, these mistakes were related to either failures to update parameters that are treated as fixed (e.g. mutations in the grazing system, farm size, etc.) or incorrect calculations with regard to the determination of Nitrogen use, the inclusion or exclusion of costs made on contractors in fodder costs, the separation of costs made for dairy or beef cattle, the measuring of stocks, distinguishing between stable and grazing period, etc. In relation to this, the evaluation of the print-out, including comparisons with others, previous years and/or norms becomes a rather precarious exercise. An extension worker sighs:

> "Do I have to look at this as a splendid result, or as the result of incorrect recording?"

In an earlier version of DELAR, a number of probability checks had been built in, but they have been removed again for reasons of software-technical complexity.

The extension workers' ambivalence vis-à-vis the norms

The attitude of extension workers towards the DELAR norms is at times somewhat contradictory. On the one hand, they seem to derive a certain amount of authority and expertise from the norms, and feel committed to defend them (the DELAR model has been developed largely by their own organization). On the other hand, however, they sometimes share the farmers' critique towards the norms, and realize that their value can be limited. In different degrees, these contradictions appeared in all meetings attended. At certain moments, the relativity of norms is recognized, but at the next, the extension workers fall back on the same norms again. It may be that such attitudes do not only vary from context to context, but also -as appeared to be the case with farmers- between different extension workers. Although systematic differences between extension workers have not been explicitly investigated, the impression was that such differences exist. Some tend to hold on to the norms in a rather strict fashion.

> "In the end the norms remain the most important, even if I cannot always indicate precisely out of which factors they are constructed."

> "The calculation of the norms for turnover and accretion are based on normative prices developed by the LEI. In reality, of course, prices vary all the time. Still, it is important to try and get close to the norm."

Whereas others seem to take the norms less seriously:

> "The norm had been set too low, for in the end, pasture has appeared to be more productive. You have exceeded the feeding norms because you have bought more expensive concentrates, so really it was perfect."

> "In fact, the norms should adapt more to special circumstances, but that would mean that in the end everybody is at the norm."

Extension workers totally disagree with some norms.

> "I have never understood that the average buying price, and the average selling price of cattle - according to the norm- should be the same. I mean, normally you would buy better cattle than the ones that you get rid of?!"

> "I have a terrible dislike for having to work with unrealistic norms. The LEI norm with regard to the price per kilo-VEM, for example, is one of those."

Similarly, in the day-to-day practice of extension work, it sometimes bothers extension workers that DELAR norms always lag behind the latest developments and trends.

> "Really, the norms for fertilization should be corrected for the mode of fertilization; that is, whether manure is spread with or without watering, with a sod fertilization gear, or by means of a manure injection machine."

"This year the norms are often not accurate, since beef cattle are corrected for in a normative fashion. When someone makes mistakes in dealing with beef cattle, they are wrongly attributed to the dairy cattle. Hopefully, DELAR will be better geared towards separating beef and dairy cattle next year."

The same holds for 'growing pains'.

"Earlier on the kilo-VEM value of maize was overestimated, due to the mode of calculation."

During individual and group meetings, both extension workers and farmers often start discussions on the correctness of a specific normative value.

"The norms are sometimes debatable; the point at issue is to *explain* the deviations."

Thereby, extension workers sometimes look like tightrope walkers. In order not to lose credibility, they frequently admit that the specific context justifies a certain level of deviation from the norms, but at the same time they wish to make clear that farm improvement remains necessary and feasible.

"Which such a good talker you really have to watch out that you don't end up saying that -after all- he could not have done differently."

A strategy that extension workers frequently use to underline the relevance of a particular norm, is to point at other farms who -supposedly in similar conditions- were able to approach the norm.

The 'agenda effect'
In all meetings attended, the DELAR print-out almost literally served as an agenda for discussion. By following the print-out from top to bottom, conversations are provided with a clear structure.

"The print-out is a good guide to keep someone with the lesson."

Both farmers and extension workers seem to be quite glad to have the ability to fall back on such a self-evident agenda. Even at the individual meetings farmers seemed to prefer to go through the whole print-out, even if extension workers always asked in advance whether or not there were particular points that they wished to bring up and/or focus on. The answer always was negative, although in the course of the discussion it always appeared that farmers did in fact bring up such particular topics. During the meetings, both farmers and extension workers took the initiative to halt at a particular point. From there, all sorts of issues were discussed, many of which were only indirectly related to DELAR, for example: problems in relation to the watering of land, considerations for buying additional land and/or milk quota, the pros and cons of changing the calving pattern, expectations with regard to government policy, new techniques for spreading animal manure, experiences of other farmers, explanations of the calculation of norms, etc.

Especially in the case of group meetings, however, this 'agenda effect' seemed to have some problematic aspects as well. At times, the DELAR print-out emerged as a rather coercive and rigid agenda. The rather ambitious inclination of some extension workers to go through the whole print-out, caused considerable time pressure. In some cases, particular figures invoked a considerable buzz and unrest among participants, to which the extension worker reacted by calling for order, after which he continued to get through the 'agenda'. In such circumstances, chances can be missed to really tackle issues that are very much alive among farmers.

In another context too, the prominent position of DELAR can be counterproductive. The advice that extension workers give to farmers (for example in an individual meeting) does not always appear to be based on DELAR, and/or translatable in DELAR terminology. In one of the meetings attended, an extension worker gave rather radical advice, that -as he admitted afterwards- was based primarily on his gut-feeling and intuition in relation to the causes of certain problems the farmer was facing. According to him, it was impossible to calculate exactly what the consequences of this advice would be in terms of DELAR results, while the farmer was repeatedly asking for such a translation. Thus, the feeling of control and predictability that DELAR seems to sometimes invoke (in fact, it could be argued that one could better speak of an 'illusion of control'), and which often seems to be cultivated by extension staff, can also work against extension workers.

Misleading the system

As I have shown, there are situations that the DELAR model does not foresee, which makes it sometimes 'necessary' to deceive the system. At times, extension workers and farmers cooperate in doing so, as appears from the following statements by extension workers.

> "If you have bad quality land in comparison to others, you should just state that you have slightly less."

> "When you feed milk to the pigs, you can do that through the cheese construction; you just pretend to have sold the milk as cheese."

> "When, you have incorrectly filled up your data in one year, and you wish to compare particularly with previous years, you should in fact fill them up incorrectly again in the next year."

8.6 Theoretical and practical implications (part 1)

In this section I will alternate between the practical and theoretical issues and the implications which arise from my case-study. It must be noted that this first case-study was but an early step in a prolonged exploratory process of deepening my insights in the use and development of communication technologies in agriculture. Chronologically speaking, I had -at the start of this case-study- not yet fully developed the theoretical and methodological approach towards CT that I have outlined in chapter 6. Therefore, the discussions in this section in part reflect a preliminary stage of 'making up the balance', which took place after this first major empirical exercise. Thus, I will conclude in this section that -next to satisfactory achievements- there were also theoretical and methodological weaknesses and omissions (see for methodological weaknesses also section 8.1). On the basis of these, I have adapted my views and (re)directed the case-studies that were conducted at a later point in time.

I have structured this effort to assess results around the guiding questions and envisaged practical contributions that have led me to select this case-study (see sections 6.2 and 8.1).

Also, I will pay attention to the guiding questions that I have posed in relation to the role of the social scientific researcher as a social actor (questions 23 to 26 in section 6.2). As this is only my first case-study, I will not always be able to provide complete answers to the issues raised.

For editorial reasons I have reversed the order of discussing questions relating to the practical contributions 1, 2 and 3.

The potential contribution of (and to) extension workers (part 1): on having different (rather than different levels of) expertise

My third practical concern centres around the potential contribution of extension workers for improving CT-use, and on the types of arrangements needed to capitalize on this (section 6.2: practical contribution 3, guiding questions 12 to 14).

In section 7.2, I have (in relation to guiding question 12) already discussed in more general terms the history of public extension worker involvement in CT-use and development. Since the development of DELAR was an initiative from the extension service itself, which was well on the way before the beginning of INSP-LV, extension workers -especially in De Achterhoek- seem to have actively contributed and stimulated its use and development. Thus, DELAR has become a relatively widely used CT, around which De Achterhoek extension workers organize a variety of extension activities. Certainly, labour reduction and -consequently- the opportunity to provide DELAR-based advice to a larger clientele, were important extension worker interests in developing this CT. Nevertheless, it emerged that the more fundamental advantage seems to be that it provides them with a relatively 'hard', farm-specific and scientifically-based agenda for discussing farm performance, and directing change. Thereby, especially the DELAR norms are dealt with as important and objective beacons, from which extension workers can derive a certain amount of authority and 'expertise'.

Both this normative connotation, and the underlying definition of extension workers as 'experts', are also implicit in the view concerning the role of extension which has recently become dominant among agro-informaticians (see chapters 2 and 7). In this view -which links up with guiding question 13- extension is identified as a (or THE) critical success factor for adequate CT-use by farmers, whereby extension workers have to compensate for the supposedly limited interpretative and analytical capacities of farmers. On the basis of this case-study, however, it can be concluded that this is a rather narrow and one-sided view of the extension workers' role and potential. Surely, extension workers can at times help farmers to interpret and analyze DELAR parameters and norms, for example, by providing amongst others insight into the underlying calculation rules. However, it has emerged that farmers themselves adhere to normative models and strategies based on them, which can deviate considerably from the DELAR model. The extent to which extension workers are able to understand and appreciate these models seems to differ per style of farming (and per extension worker). In any case, it seems clear that farmers are their own 'experts' in grasping the underlying logic of their farms. Moreover, farmers must frequently provide additional context information which is indispensable for proper interpretation and analysis by either extension workers or farmers. As I have demonstrated in section 8.5, many DELAR-related extension worker/farmer interactions can be seen as *a search for the most* *adequate interpretation*, in which both parties engage actively, and bring in *a different* (rather than different levels of) *expertise*, and in which they can also arrive at different conclusions. Therefore, I would argue that the potential of extension workers in improving DELAR-use lies primarily in acting as a partner for discussion, which -starting from an agenda raised with the help of DELAR- stimulates farmers to think critically (that is, from a different perspective) about their farms. Thus, in this context, extension workers may be more useful if they take on a role as facilitators of a process of mutual learning, than as 'knowledge transfer agents' (Röling, 1992c).

Despite the important role that extension workers may play, I have also shown that many farmers seem quite able to reason about and analyze DELAR results without the physical presence of extension workers (which does by no means exclude the possibility that they are 'present' in a virtual manner).

I would like to discuss criteria that DELAR-like CT might have to meet in order to facilitate such extension functions (guiding question 14) together with a somewhat broader discussion on criteria in the next section.

Design-criteria for facilitating integration of knowledge from different epistemic communities (part 1): the importance of the 'external' design

My second practical concern encompasses the formulation of criteria (both at software-technical and organizational level) for designing CT which facilitate adequate and balanced integration of knowledge from different epistemic communities (see section 6.2: practical contribution 2, guiding questions 7 to 11; guiding questions 9 and 11 will be discussed in later chapters).

In section 7.3, I have -in relation to guiding question 7- already extensively discussed different types of computer-based communication technologies, and their underlying models and rationales. In principle -and contrary to Frouws & Van der Ploeg's argument (see section 5.1)- it seems possible to include knowledge from any epistemic community in a communication technology (at least to the extent that it can be made discursive), for I have argued in chapter 5 that -at the fundamental level- it is hard to differentiate between knowledge developed by, for example, scientists or farmers. To the extent that knowledge originating from different epistemic communities is supplementary rather than contradictory it can also be integrated into one and the same CT; in DELAR, for example, knowledge from rather different scientific disciplines and networks is combined and integrated. This case-study, however, reveals that there are several practical drawbacks if it comes to integrating farmers' knowledge and scientists' knowledge into a DELAR-like CT.

First, for practical and economic reasons, CT in agriculture are usually developed for relatively broad categories of farmers; i.e. they are 'confection' rather than 'tailor-made' packages (see chapters 2 and 7). Second, this case-study indicates once more that agriculture is characterized by a significant measure of diversity, whereby different (categories of) farmers apply different models of thought which can contradict each other considerably. Third, the study shows that a considerable amount of relevant knowledge is rather context-specific as well. Moreover, what is 'relevant knowledge' can vary considerably through time, as a result of increasing experience, changing societal conditions, technological developments and changing farming styles and practices at farm level. Finally, it would be almost impossible for farmers (in part due to time constraints and lack of software development skills) to develop complex systems like DELAR themselves, so that if their knowledge was to be included it would have to be elicited and made explicit by others. Apart from the fact that it may be impossible to make all relevant knowledge explicit (if only because of the magnitude of knowledge 'reservoirs'), this can pose considerable communication problems between epistemic communities of farmers and 'knowledge engineers'.

In the context of the foregoing, I must conclude that increasing formalization of agricultural knowledge into more and more complex models underlying CT (guiding question 10), poses serious risks if such models are used for guiding interventions. That is, from the perspective of individual farmers the results of complex calculations may have to be looked at as suffering from a considerable multiplication of errors. Moreover, due to the almost inherent black-box character of complex CT, such errors can be hard to detect.

Although I would -in relation to guiding question 8- argue that bringing about an integration of knowledge from (different) scientific communities and (different) farmer communities is vital for guiding farm development, the prospects of bringing about such an integration *within* the 'internal' design of a DELAR-like CT (see section 7.3) are rather limited. Instead, the case-study suggests that such an integration is more realistically achieved by means of an adequate 'external' design, which includes amongst others the way the CT is organizationally embedded (see section 7.3). Clearly, extension-related arrangements can form an important element in such an external design.

Towards general design-criteria for improving the learning potential of DELAR-like CT
Below, I will formulate some practical recommendations for improving the internal and external design of DELAR. The implication of the above elaborations is that the feasibility of further specifying the DELAR model with the aim of making it 'fit' different styles of farming is rather limited. Therefore, my suggestions will focus on improving the *quality of discussions* on the basis of DELAR, for such discussions seem vital for reaching an adequate interpretation of results, as inherently connected with the bringing about of an integration of knowledge from different epistemic communities. In other words, I would like to improve the *learning potential* associated with DELAR. In relation to this, I will also try to develop more general design-criteria for DELAR-like CT.

First, the quality of discussions around DELAR could benefit from improving its transparency for both extension workers and farmers. In this manner, it might be avoided that discussions are frustrated by confusion about the calculation rules which are applied. To this end, there is considerable scope to improve documentation to extension workers and farmers. A more radical solution would be to simplify and limit the DELAR-model. Second, discussions could be improved if the agenda which is implied by the DELAR print-out would be more dynamic and up to date. At present, a considerable number of farmers become 'bored' with DELAR, for it stops triggering off new insights after a few years. An important prerequisite for increasing the flexibility of DELAR, is again that the model is simplified, so that new parameters can be more quickly incorporated. A limitation and simplification of the model could, for example, be achieved as follows:

(1) The DELAR model can be selectively limited and expanded on the basis of a periodical evaluation of parameters that -at a given point in time- have the attention of both farmers from different farming styles and extension workers. In this manner new parameters can be regularly included, while those that are no longer relevant can be excluded.
(2) The DELAR norms could be replaced by (possibly style-specific) reference values. The norms are inherently debatable, and it is highly questionable whether they are more valuable than equally debatable reference values, which have the advantage that they can be calculated in a much more transparent manner. These reference values could, for example, consist of the averages of a particular selection of farms or even one specific farm. The relevant selection criteria could be periodically determined by the farmers themselves.

Third, it might improve discussions and advice, if extension staff had more insight into, and more appreciation of, diversity in farming (as expressed, for example, in farming styles). In giving more adequately tailored advice, it is crucial that extension workers identify with (diverging) strategies and principles of farmers. This does not imply that they should uncritically accept these strategies and principles. The strength of (and the justification for paying) extension workers is, of course, that they can offer a *different* perspective. However, in the end extension workers need to be able to value a particular farm on its own merits, and give an adequate advice in the context of the strategies and principles that farmers themselves wish to adhere to. In order to achieve such understanding and appreciation, it may be necessary to launch an awareness-raising campaign within extension services.

Fourth, extension workers could play a role in stimulating and facilitating discussions in group meetings. Special attention could be paid to encouraging the emergence of study clubs. In such study clubs, the quality of discussions can be very high due to the fact that anonymity is lifted, so that specific contexts can be taken into account. In such meetings both extension workers and farmers can draw upon and learn from an enormous stock of knowledge. The extent to which this stock of knowledge is indeed efficiently used, depends partly on the way extension workers and farmers organize such group meetings. In this context it may be useful to develop guidelines and techniques which might help in increasing access to available knowledge and experience. Given their special qualities, the supervision of study clubs could indeed be an effective and efficient extension activity.

Individual meetings, of course, have a high learning potential as well. Moreover, they are better suited for giving specific advice than group meetings are. In section 8.5, I have indicated that there are several fundamental bottlenecks in relation to the provision of written advice on the basis of DELAR. Especially when transparency of the DELAR model is improved, I would propose that the written advice can be abolished altogether.

At the more general level, the following design-criteria for DELAR-like CT can be formulated; they should: (a) be transparent; (b) be flexibly adaptable through time; (c) anticipate diversity by providing various types of parameters, facilities and options; and (d) include organizational arrangements that allow for open-minded, context-sensitive discussions within and between epistemic communities.

On developing relevant empirically-based classifications of farmers (part 1): the relevance of farming styles and homogeneous target-categories for CT-development

My first practical concern is the generation of methodologies which can help to make empirically-based classifications of farmers that are relevant to CT-development (section 6.2: practical contribution 1, guiding questions 1 to 6). Clearly, I have in this chapter described a methodology of self-classification into farming styles (see section 8.2) that I expected to be adequate in this respect. In order to evaluate my anticipations in relation to this methodology, I need to discuss to what extent it actually proved to be 'relevant' and 'empirically-based'.

The adequateness of the classification into farming styles

With regard to the relevance of the classification into farming styles for the development of CT (guiding question 6), it can indeed be argued that it has helped me to detect meaningful differences in DELAR-use, which in turn led to the identification of various problems, solutions and criteria for CT-design. Nevertheless, the question can be asked whether it specifically has been the classification into styles of farming that helped to generate relevant insights, or my interest in diversity in general. After all, both my suggestions for the improvement of DELAR, and the more general design-criteria that were formulated in relation to DELAR-like CT, might well have been arrived at on the basis of my empirical material *without* making the particular distinctions between Multiple Goalers, Machinemen, Fanatical Farmers, etc. In other words, other classifications of diversity might have been equally (or perhaps even more) insightful. This issue leads immediately to the supposedly 'empirically-based' character of the classification.

The notion of an 'empirically-based' classification was first introduced in chapter 2, whereby it was implied that the target-group classifications used in relation to CT-development should somehow be inductively rooted in 'empirical reality'. In chapter 7 (sections 7.2 and 7.5), I have criticized presently used classifications for starting from deterministic theoretical models, and being politically and/or ideologically rather than empirically informed. In response to this, I have outlined (in section 8.2) a particular methodology for classifying farmers according to 'their own' categorization of diversity (i.e. a methodology for generating an ethno-taxonomy). Although I would maintain that this classification bears -in the context of CT-development- greater relevance to 'empirical reality' than, for example, the classification into 'frontrunners', 'followers' and 'laggards', it cannot be maintained that the classification into farming styles is solely 'empirically-based' and/or a pure ethno-taxonomy.

As I have shown in section 5.1, the styles of farming approach is connected with actor-oriented theoretical convictions. Similarly, the dimensions (scale and intensity, see figure 8.1) which were introduced to farmers in an effort to elicit farmers' conceptualization of diversity, are far from incidental, but rooted in theoretical debates concerning the integration of farming households and enterprises into the wider capitalist economy (see Long et al., 1986; Van der Ploeg, 1990a, 1990b; Friedmann, 1980; Bernstein, 1987). In that sense, a classification into farming styles has a stronger theoretical basis than Nooij (1993) seems ready to acknowledge. Thereby, it is of interest to note that the dimensions of scale and intensity emerge as important dimensions that others (farmers, extension workers, agro-informaticians) use for separating 'frontrunners', 'followers' and 'laggards' as well, which means that this classification is -in part- conceptually related to the one into styles of farming. This partial familiarity of the two classifications is, for example, reflected in: (a) the very fact that extension workers' evaluations of farms differ systematically from style to style (tables 8.8 to 8.10); (b) the fact that farmers -apart from using labels such as 'cowmen', 'machinemen', etc.- also frequently referred to 'frontrunners' and 'followers' in the qualitative interviews; and (c) the partial grounding of both classifications in interests and convictions relating to capitalist development.

In all, the classification into farming styles was actively constructed and selected by the researchers in direct interaction with farmers, and against the background of particular academic, political and ideological debates and interests; in this respect this classification does not differ from any other (see section 7.5).

If -as I have argued in earlier theoretical elaborations- all classifications have theoretical, political and ideological connotations, the question remains which classification (if any) is most adequate. One part of the answer is, of course, that this depends on the historical (Nooij, 1993) and spatial context. In different historical and spatial settings diversity in farming has -amongst many others- been classified (and explained) in terms of: (a) their geographical location vis-à-vis markets (Von Thünen, 1930); (b) cropping system in relation to soil-type (Staring, 1870); (c) speed of technological adoption (Rogers, 1983; Van den Ban & Hawkins, 1988); (d) levels of commoditization (Friedmann, 1980); (e) the degree of subsumption of internal and external production relations (Whatmore et al., 1987a, 1987b); (f) labour availability, household composition and/or stages in the family cycle (Chayanov, 1966; Mainié, 1971); (g) cultural patterns (Hofstee, 1985); and (h) gender relations within the household (Aarnink & Kingma, 1991) (see for several additional modes of classification Blanc & Allaire, 1979).

However, even within these time and space contexts, neither of these classifications can be understood without taking into account who made the classification, for what purposes, from which theoretical background, etc. Thus, it can be argued that no objectively identifiable and generally applicable 'most adequate' classification of diversity in farming exists. I must therefore resort to the saying that 'the proof of the pudding is in the eating', by which I mean that an 'adequate' classification is a classification that -in a particular context- satisfactorily helps to fulfil the purposes for which it has been developed.

To me, the primary purpose of the classification into farming styles was to understand (differences in) the use of DELAR by farmers. Indeed, the classification has been helpful to detect and explain differences in the day-to-day use of DELAR, and in that sense it has been quite adequate. The frequently used classification of farmers according to adoption speed may have been adequate for other purposes (e.g. for presenting non-adoption as a temporary phenomenon, for obtaining subsidies for the development of Standard Information Models, etc., see section 7.5), but it has not helped to provide much insight in CT-use, other than that some start using it sooner than others, whereby it is (rather speculatively) assumed that those who do use always "feel a need to profoundly analyze the available information" (Klink, 1991a:10; transl. CL) and are capable of doing so, whereas others are in need of supervision.

Nevertheless, some of the differences in DELAR-use discussed in sections 8.3 and 8.4 are fairly subtle in both qualitative and quantitative terms. In combination with the earlier assessment that my suggestions for improving DELAR might well have been arrived at without this particular classification, this leaves me with the pressing question whether or not I would have arrived at sharper distinctions and design-criteria if I had from the outset started from other dimensions and/or methods for classification. In particular, I could -in a next case-study- look for dimensions that are of a more directly 'knowledge-related' nature than scale and intensity (see chapter 9).

Problematizing the making of homogeneous target-categories
On the basis of the foregoing it can -in relation to guiding question 1- be asserted that the making of a classification of farmers is by no means a futile exercise. In my view, this theme has not been sufficiently problematized in extension science. Wapenaar et al. (1990:103), for example, suggest that making a segmentation and analysis of target-categories is something that every extension worker should be able to do in their day-to-day working routine. On the basis of van Woerkum (1987a), Wapenaar et al. propose that homogeneous target-categories can be identified by studying diversity within populations (by means of qualitative and/or quantitative methods) with respect to communicative pre-dispositions (information need, foreknowledge, attitude vis-à-vis sender and message, mode of decision making, and media use), and their interconnections with demographic variables (age, education level, sex, region, political convictions, etc.). Furthermore, it is suggested that attention should be paid to 'behavioural determinants' in relation to what people 'can', 'want', 'know' and are 'allowed to' (Wapenaar et al., 1990:105-106). In all, Wapenaar et al. (1990:107) assert that 'target-group research' consists of the following phases:

- general reconnaissance of the population
- segmentation into homogeneous categories
- analyses of target-category
    . on relevance of the offer/message
    . on how it can be reached
- pretest of offer/message and method
- extension campaign
- evaluation

In the context of this (case-)study, Wapenaar et al.'s conceptualizations are somewhat problematic for various reasons. First, they apparently assume that classifications can be 'rationally' designed for one single purpose, i.e. stimulating a particular behavioural change on the side of the client/receiver. In chapter 7, however, I have shown that -in practice- segmentation of farmers into target-categories serves rather different purposes as well, whereby institutional interest and convenience seem to play an important role. The conceptualizations and procedure presented by Wapenaar et al. offer little opportunity to understand and/or deal with these phenomena. Although the model shows awareness of political issues (in the sense that the central aim is persuasion), it fails to fully grasp the manyfold social dimensions of classifications. One could -quite correctly- argue that the model was not designed for such purposes; nevertheless, the lack of warning and critical reflection remains a serious omission.

Second, and like other conceptualizations in extension science (see section 4.2), the model itself seems to draw heavily on mechanistic and deterministic views of behaviour, and classifications on the basis of it are likely to suffer from the same problem. More generally, Wapenaar et al. fail to draw attention to the implicit theoretical and interpretative dimensions that inherently underlie classifications.

Third, the position of the offer/message in the procedure is somewhat paradoxical. On the one hand, the 'attitude towards the message' is presented as a criterion for segmentation (i.e. the message is known before segmentation), whereas on the other hand, the whole idea of segmentation seems to be that offers/messages need to be adapted to the different target-categories. As I have shown in relation to CT-development (see section 7.2) this may result in the treating of the offer/message as fixed (e.g. as a modern farmer you need an 'integral' MSS), whereby subsequent discussions only focus on how the offer is to be 'wrapped' so as to manipulate successfully farmers to adopt it. As the present case-study shows, detailed analysis of target-categories can render such original messages problematic (i.e. 'integral' MSS are associated with various practical and conceptual problems). Thus, although the implication of my earlier discussion in relation to the 'proof of the pudding' is indeed that one needs some preliminary idea of what intervention one wishes to make (and for what purpose) before developing an adequate classification, I would argue that this preliminary idea needs to remain under permanent scrutiny.

Rationalist bias, stability and anticipation

The guiding questions 2 and 3 can be answered affirmatively, since my case-study (combined with the wider study by Roep et al. (1991)) quite clearly exposed both the social nature of the different styles of farming (i.e. they can be seen as different strategic positions vis-à-vis economic, technological and political developments), and farmers' capacity to partly structure their own environment (including knowledge networks) (see also section 5.1). However, I must point out an important shortcoming in this respect as well. In recent writings on farming styles (see section 5.1 for references), farming styles emerge predominantly as well-elaborated and explicit strategies that are consciously adopted by individual farmers, and I must admit that my case-study is no exception. Farmers' doubts and uncertainties are hardly exposed, nor are less discursive forms of consciousness and less strategic types of action. Similarly, although this chapter makes plausible that different patterns of social relations exist, it hasn't been adequately shown how these have emerged, and/or through which social processes styles of farming have been constructed in time and space. Thus, there is -at present- a slightly rationalist bias in the approach, which -in a next case-study- I should try to overcome.

Since little attention has so far been paid to how styles of farming are socially constructed, there is only limited insight in how they change. Present studies show indeed that the way farming styles are *expressed* changes considerably over time (e.g. in the light of new technological developments, environmental legislation and production limitation, see Roep et al., 1991). However, changes in the underlying strategies and their normative, ideological, interpretative and political dimensions, remain undocumented. Nevertheless, from a theoretical point of view, such changes are bound to occur. Moreover, there is sufficient evidence that the practical logic of farming styles changes over time quite rapidly, so that -in relation to guiding question 5- it can be concluded that farming styles cannot be treated as a stable phenomenon. That is, it may be that farmers can be correctly associated with particular styles of farming in the medium long term, but within this period their practical logic is likely to change considerably (so that the making of CT models reflecting the particular style of farming is hazardous). In the long term, it can be expected that it becomes increasingly misleading to adhere to a particular classification of farming styles (or any other classification of farmers) altogether.

Earlier in section 8.6, I have already underlined the importance of anticipating diversity in CT-design (guiding question 4). Thereby I have stressed that, although it is possible to formulate criteria for the internal design of DELAR-like CT, the prospects for anticipating diversity by means of the external design seem more promising. For purposes of farm comparison -which indeed emerges as a very important aspect of DELAR-like CT- a certain level of standardization in the definition and measurement of parameters is of course desirable. Even then, however, one cannot speak of truly standardized parameters since I have shown in section 8.4 and 8.5 that -in the context of a particular farm- the *meaning* of such parameters can be rather different, even if they have numerically the same value. Furthermore, it can be concluded on the basis of this case-study that the usefulness of standardizing certain modes of reasoning in models underlying CT is rather debatable. At the same time, it has been shown that many farmers -at least to a certain extent- are quite able to deal with the complex and normative internal design of DELAR, and that they have found ways to 'correct' for the model if they find it unsuitable. Nevertheless, it would improve the learning potential of CT if they would be externally *and* internally designed to adequately account for, recognize, make visible and appreciate strategic diversity.

The social scientist and the production of social change (part 1): setting out for the second case-study

If, in retrospect, I look at the contribution of the social scientist towards social change -and in particular the development of CT- by means of conducting this case-study, I can safely say that this contribution has been rather minimal as yet (guiding question 24). Although publications and public presentations may have helped to arouse some attention among agro-informaticians and extension workers to such issues as diversity and the importance of study clubs, recommendations to change the 'internal' design of DELAR have not been followed up. Although especially the newly formed IKC for Animal Farming has shown considerable interest in the farming styles approach (Wieling, 1991:v), follow-up research has focused especially on farming styles in relation to environmental issues (Roep & Roex, 1992). Since, eventually, I wish to be able to make practical contributions to CT-development, it is important to analyze how this limited impact has come about, so that in a next case-study I might improve in this respect.

A first and very important reason is, of course, that DELAR had already been fully developed before this case-study took place. Although at the time of research DELAR was in the process of being rewritten, this exercise had already been started earlier on, and was mainly oriented towards expansion of the model, and the improvement of both the software-technical design and documentation. Second, as mentioned in section 8.1, the study took place in an institutional vacuum. No organization had specifically asked for the study, and those organizations whose cooperation was required were in the process of being liquidated in the privatization process. Although this provided considerable space for the researchers to pursue their own interests, this resulted in little commitment to the results from the side of those who are professionally involved with DELAR. Third, the researchers did not give a very high priority to making practical contributions at that point in time. In relation to guiding question 23, it must be mentioned that, from the perspective of the researchers, the wider research project was primarily geared to making a (qualitatively and quantitatively supported) challenge towards the dominant interpretation of agriculture and diversity in the Netherlands. Making practical contributions was a second and/or later priority. Since at no point in the discussions with IKC staff the researcher got the impression that serious adaptations of DELAR were considered, and/or that resources were available to do follow-up research on adapting DELAR, no further energy was spent.

On the basis of these insights, I decided that a next case-study should: (a) be more explicitly aimed at contributing -at an early stage- to a concrete process of CT-development; and (b) should not take place in an institutional vacuum, but instead have a 'client' that would be seriously committed to the research results, without putting the researcher in too much of a straitjacket. If these criteria were adhered to, it was expected that more definite insights could be obtained in relation to guiding questions 23 to 26 (see section 6.2).

Notes

1. Under my supervision, Marlèn Arkesteyn has conducted a detailed study on the history of DELAR. In time, this study was carried out *after* the case-studies presented in the chapters 8, 9 and 10 were conducted. My original idea was to provide a detailed account of it in this book. For reasons of time and space, and because of the fact that the study did not generate a great deal of practical and/or theoretical insights in addition to those derived from the development-histories presented in chapter 10, I decided to only provide a brief outline in this section.

2. Although it seems that the Ministry has never objected to the fact that extension workers were involved in making 'partial administrations' manually, and has even sent senior extension service staff to post-academic computer courses, the Ministry did not want the extension service to be involved in the organization and exploitation of computer programs and services that could be provided commercially as well. Thus, CRA requests for subsidies were not rewarded.

3. The extension services and the main accountancy bureau in the Northern province of Friesland stick to their own system, called MELVO.

4. According to correspondence, the development costs were estimated at about fl. 310,000.-.

5. These independent societies needed to be erected in order to avoid that economic and fiscal administrations would be kept by the same institution, which would legally allow the Treasury to have access to the former.

6. There exists, however, a so called DELAR Extension Support System, in which the model underlying DELAR can be used for simulation purposes. It can, for example, calculate how revenues minus feed & fodder costs would change if less fertilizer was applied. Thus, it is possible to use the DELAR ESS for optimization purposes, by simply running a large number of simulations like this. According to IKC staff, this ESS is especially useful for those farmers who -according to the DELAR model- do well. In 1990, however, the system was hardly used. IKC staff attribute this phenomenon to the fact that its use is too time consuming, and that correct interpretation of the outcomes requires a very high familiarity of extension workers with the DELAR model.

7. The option of 'individual (instead of average) animal registration', whereby certain revenues and feed/fodder costs are registered in relation to individual cows, was added to DELAR at a later stage, and had -at least in 1989- not aroused much enthusiasm among De Achterhoek farmers. Similarly, very few farmers made use of the even more recently added option to register additional costs within DELAR (such as those related to animal health, breeding and contract work).

8. Some individuals who were closely connected with the development of DELAR worked in De Achterhoek in the early eighties. Thus, DELAR has a comparatively long tradition in De Achterhoek, which is also reflected in the fact that -relatively speaking- a large number of farmers participate. In the research area (consisting of the working areas of four extension workers encompassing five sandy districts of De Achterhoek) 142 dairy farmers participated in the 1986/1987 season. In the fieldwork period (1989), almost all participants in De Achterhoek had chosen for the 'average animal registration' option within DELAR. Extension staff estimated that in the research area 75% of DELAR participants received extension service advice.

9. These were: the number of milking cows; milk production per milking cow and per hectare; feeding costs per quantity of milk; stocking density; use of fertilizers; and concentrate consumption per cow.

10. These were: (1) relatively large number of cows combined with relatively low production per hectare/cow; (2) relatively small number of cows combined with relatively low production per hectare/cow; (3) relatively large number of cows combined with relatively high production per hectare/cow; (4) relatively small number of cows combined with relatively high production per hectare/cow.

11. Non-response was less than 10%, and the remaining farms were not interviewed since no appointments could scheduled within the planned period.

12. Although strictly speaking the discriminating variables in discriminant analysis should be of an continuous nature, the technique is widely used with discrete (pseudo interval) variables as well. In relation to the discriminating variables, discriminant analysis requires: (a) multivariate normality, and (b) homogeneity of variance-covariance matrices. The multivariate normality requirement implies that the scores on the discriminating variables are independently and randomly sampled from a population, and that for each combination of values of two or more discriminating variables, the scores on the remaining variables are normally distributed. Although, currently no tests are available to test this (Tabachnick & Fidell, 1989:511) it is suggested that normality of the individual discriminating variables is a useful (if incomplete) check (Norusis, 1986:B-31). In relation to this we have to acknowledge that three of the six discriminating variables (questions 1, 3 and 5 in table 8.1) appeared to be significantly skewed, while one of these (question 5 in table 8.1) is characterized by significant kurtosis. However, discriminant analysis appears to be robust to failures of normality, especially when caused by skewness; furthermore, the normality requirement is relaxed when the primary goal of the analysis is classification rather than inference (Tabachnick & Fidell, 1989: 511, 510).
The homogeneity of variance-covariance matrixes can be assessed by an inspection of scatterplots of scores on the first two canonical discriminant functions produced separately for each group (Tabachnick & Fidell, 1989:512). Since the overall sizes of the scatterplots appeared to be roughly equal, there was indeed evidence for homogeneity of variance-covariance matrices.

13. A stepwise procedure is used primarily if one wants to identify the most important discriminating variables out of a longer list of independent variables. Given our purposes with the discriminant analysis it is obvious that we wished to include all six discriminating variables regardless of the discriminating power of each of them separately. Thus, the direct method was chosen for.

14. An essentially similar picture arose when we examined the (Pearson) correlation within each group (according to the classification based on the outcome of the 7th question in table 8.1) between the values of the function and the values of the discriminating variables (see also Roep et al., 1991:34).

15. A similar conclusion emerged from an earlier study on diversity in farming, which was conducted in Ireland (Leeuwis, 1989b).

16. In all analyses of variance which are presented in this book, a 'classical experimental' approach was adopted in order to correct for unequal cell frequencies.

17. The DUNCAN procedure is a relatively mild procedure for comparing all possible pairs of group means. The procedure can be used whether or not the analysis of variance is significant. DUNCAN is approximate if the group sizes are unequal.

18. For raw milk fed to calves, DELAR calculates the factory prices for milk as costs, which makes this way of feeding more costly than feeding milk replacer. Many multiple goalers (and others) are of the opinion that raw milk should be valued against either production costs, or factory price minus super levy (a fine on exceeding milk quota).

19. Unfortunately, I did not have access to normative figures concerning all parameters mentioned in box 8.1 of section 8.1.

20. Average deviations were calculated in both *relative* terms (whereby positive and negative deviations 'compensated' for each other, so that it was possible to establish whether -on average- deviations in a group were positive or negative in the numerical sense), and in *absolute* terms (whereby all deviations were treated as being above zero, so that they become in fact indications of their magnitude, without offering the opportunity to establish the average direction of the deviations).

21. The parameters regarding revenues minus feed & fodder costs were deemed 'important' by almost all farmers. Revenues minus feed & fodder costs per cow were deemed important by 100% of farmers. Those per hectare by an overall 84% (MG:90%, TF:100%, PF:88%, CM:79%, MM:57% and FF:81%), and those for the enterprise as a whole by overall 88% (MG:100%, TF:92%, PF:92%, CM:88%, MM:71% and FF:81%). From the qualitative observations, however, it appeared that there are nevertheless important differences in the extent to which people actually reckon with, and refer to these parameters. During the interviews, it appeared that most farmers would in the case of these more abstract economic parameters respond that 'of course' these parameters were important, whereby it was clearly implied that it was a stupid question. The same holds for the questions relating to the formulation of goals vis-à-vis the corresponding norms; 'of course' farmers wanted to be either at or above these norms, because of their direct link with farm income. Thus, the answers to these questions should not be taken too seriously.
Something similar occurred in relation to only those more technical parameters that related to feeding costs and concentrate feeding. Feeding costs per milking cow were deemed important by 99% of respondents, concentrate feeding per milking cow in the grazing period by overall 88% (MG:100%, TF:92%, PF:79%, CM:85%, MM:86% and FF:94%), and those in the stable period by overall 95% (MG:100%, TF:92%, PF:92%, CM:97%, MM:100% and FF:94%). This is not surprising since feeding costs are indeed a major cost on any farm. However, the questions relating to goal formulation vis-à-vis the corresponding norms were dealt with by farmers in a much more serious manner than in the case of the economic parameters. This is also reflected in the much wider variation of answers that was obtained in relation to these questions.

22. In the 'individual animal registration' option in DELAR, a number of parameters such as accretion, milk yield per cow, etc., are provided on the print-out. However, data on individual costs and individual revenues minus costs are lacking.

23. At least in so far as they connect with the ideology of growth that they have internalized, since models for sustainable agriculture have not really touched ground among fanatical farmers (see Roep et al., 1991).

24. One could also argue that this indicates that the fanatical farmers are less accurate in filling up the record-book, but given: (a) the complexity of this activity; (b) the rather huge number of mistakes that emerged when attending DELAR-related meetings (see section 8.5); and (c) my qualitative observations, I do not think that this would be an appropriate interpretation.

25. As I have argued in an earlier note, my questions in relation to goal formulation vis-à-vis these more economic norms were not always answered seriously (the majority of farmers would respond that "of course we want to be above the this norm"). Thus, we might also say that fanatical farmers have consistently answered questions relating to these parameters somewhat more seriously than others.

26. On the basis of a survey that was carried out by a (anonymous) student on behalf of the main farmers' organization (NCB) in the South of the Netherlands, it can be argued that we should not over-emphasize the importance comparing with the DELAR norms. The survey was conducted (probably in 1988) among 67 southern DELAR users. In this survey, a question was included which indirectly indicates the importance of comparison with DELAR norms. In contrast to the approach adopted in my study, the farmers were not directly asked to evaluate comparison with the norms against other opportunities for comparison (see table 8.13). Instead, they were asked to rank-order several parts of the partial administration according to decreasing importance. From the results, it emerges that - although comparison with norms is deemed more important than comparison with other farms- the own results are considered much more important than the normative analysis. To the extent that this can be equated with an implicit comparison with one's own results in previous years, these results partly contradict the ones arrived at in this study (see table 8.13 and the table below).

Table 8.17: Interest expressed in different parts of DELAR by 67 southern DELAR users in 1988. (Source: NCB, 1988).

	most important	of second importance	of third importance	of fourth importance
data concerning feed & fodder use and production	10.4%	47.8%	29.9%	11.9%
balance parameters (revenues minus costs)	74.6%	16.4%	6.0%	3.0%
normative analyses	17.9%	23.9%	44.8%	13.4%
external farm comparison	3.0%	13.4%	13.4%	70.2%

27. In the survey, farmers were asked to indicate what, according to them, would be the ideal number of milking cows. The averages responses per style were as follows: MG: 51 cows, TF: 55 cows, PF:

69 cows, CM: 62 cows, MM: 65 cows and FF: 75 cows. The number of milking cows in 1989 was: MG: 42 cows, TF: 42 cows, PF: 52 cows, CM: 44 cows, MM: 45 cows and FF: 58 cows.

28. The need for this coordination is related to the fact that -in contrast to the pre-1990 situation- extension workers do not have their own exclusive region any more, and therefore farmers no longer deal with only one fixed extension worker.

29. Although towards the end of 1989, a number of extension workers were very active in the organization and supervision of study clubs, there has been a shift in recent years -at least in the dairy branch- from group extension activities towards individual extension activities. On the occasion of the privatization of the 'Consulentschappen' into the DLV (from 1990 onwards), the discussions on the usefulness and efficiency of group meetings intensified. Thus, during the fieldwork period (1989/1990), the extension workers interviewed felt that study club activities were under pressure. At present (1992), DLV maintains that the supervision of DELAR study clubs is an integral element of the organization's offer to dairy farmers, whereby they strive to stabilize the ratio between individual versus group extension activities at 75% against 25% respectively. Dairy farmers who want to participate in a DELAR study club pay (in 1992) 250 guilders per person in order to have an extension worker attend three group meetings (at the time of research this used to be almost free). The contents of two of these meetings can be freely determined in consultation with the extension worker.

Chapter 9

Diving into the arena of CT-supported enterprise comparisons among horticulturists (case-study 2)

In contrast to my first case-study (chapter 8), the second was aimed much more explicitly at contributing to an existing process of CT-development. To this end the researcher cooperated closely with a group of cucumber growers in the South of the Netherlands, who wished to improve the quality of the partly computerized Enterprise Registration and Comparison System (from now on ERCS) that they themselves had previously developed.

In section 9.1, I will first discuss why and how this case-study was selected, and proceed to provide some background to the phenomenon of enterprise comparisons among competing horticultural entrepreneurs. Also I will describe the methodology adopted. More details on the contents and use of the locally developed ERCS can be found in section 9.2. In section 9.3, I will introduce an approach towards operationalizing diversity that differs from the styles of farming approach in that it starts from concrete practices rather than from more general orientations, and helps to generate a variety of classifications rather than a single one. Furthermore, I will analyze enterprise comparison-related practices in section 9.4, and elaborate on both diversity with respect to such practices and their social dimensions. Simultaneously, I will on the basis of these analyses attempt to identify concrete design-criteria that any CT aimed at supporting growers' enterprise-comparison practices might have to meet in order to adequately do so.

The extent to which the southern cucumber growers' self-developed ERCS appeared to meet these design-criteria, is briefly elaborated in section 9.5, and -in relation to two externally developed ERCS- a similar (but more extensive) exercise is undertaken in section 9.6. It will appear that meaningful differences between the packages exist, and that their relative success can be plausibly explained with reference to the earlier formulated design-criteria.

The consequences of this study for the actual course of events in my empirical domain will be explored in section 9.7. Finally, theoretical and practical implications of the case-study will be simultaneously discussed in section 9.8. In this final section, I will reflect on: (a) the approach towards classification adopted; (b) on ERCS, climate computers and the integration of knowledge from different epistemic communities; (c) the potential contribution of extension workers; (d) approaches towards identifying information needs; and (e) the role of the social scientist in producing social change.

9.1 Case-study selection, background and methodology

On top of my requirement that case-studies should be likely to provide insight in relation to the practical contributions I wish to make (see chapter 6), I have in the final section of the previous chapter identified some additional conditions. Most importantly it was argued that in a future case-study I should: (a) commit myself to contributing to a concrete process of CT-development. Preferably, these contributions were: (b) to be delivered at an early stage in the development process; and (c) to a 'client' who was seriously interested; but who (d) would at the same time allow the researcher enough space for manoeuvre to pursue additional research interests. Furthermore, the case-study should: (e) further our insight into how diversity in agriculture is socially constructed. In relation to these last three conditions, it was thought to be most promising to look for a case-study in which a group of farmers were themselves initiating and developing a CT. Moreover, taking up a group of farmers as 'clients', would expectedly provide some insight in research questions relating to the opportunities for user-participation in CT-development (i.e. practical contribution 5, see section 6.2).

After some looking around, the researcher -via a regional extension worker- came across a regional cucumber study club in the South of the Netherlands that consisted of 80 members. This study club appeared to have developed their own Enterprise Registration and Comparison System (ERCS), in order to support and facilitate exchange of registration material in and between different sub-groups (or 'excursion-groups'). According to the extension worker, the southern study club wished to further develop their system, and might be in need of external support. At that point in time (September 1989), the 54 members that participated in the scheme on a weekly basis, had to fill up a form with climate, crop-protection, feeding and energy use data. At a central address, this registration material was entered in a database, together with production figures on that particular week that were provided by the auction. Within one week, growers would get an (officially anonymous) print-out of the registration material of all 54 enterprises.

At the initiative of the researcher, an acquaintance meeting was held between the researcher and members of the Registration Committee of the cucumber study club. During this meeting it appeared that the committee was not satisfied with the functioning of their own ERCS. Both participation and discipline had been eroding. It was put forward that, although 'correct' production figures were now available[1], it still seemed impossible to draw the expected *general conclusions* with regard to the effectiveness and profitability of certain production practices. Thus, the committee was seeking for the adaption of their ERCS in ways that would improve the possibilities for drawing such conclusions.

At the same time, the study club was confronted with the development of two communication technologies through which registration material could be exchanged much quicker than with the present system. One of these systems was developed by SITU[2] in close cooperation with the Society for Dutch Horticultural Study Groups (NTS; see further on). The other system was developed by a small firm (DACOM) in the North of the Netherlands. Given the problems with regard to their own ERCS, the committee was tempted to adopt one of the two CT (i.e. they were tempted to define the problem in terms of the available solution), but they were not sure which one to choose[3]. The institutional environment strongly supported the package that was developed by 'their own' SITU/NTS, but the growers knew that, unlike the SITU/NTS package, the competing package allowed for graphical representation of data.

In my view, this context seemed very promising for conducting a case-study. It was expected that a case-study would yield insight in the guiding questions relating especially to the practical contributions 1, 2, 3 and 4. Furthermore, my additional requirements seemed to be met. Moreover, the context provided an opportunity to study no less than three different ERCS (one of which was predominantly a postal system, whereas the other two included the use of CT), which added to the richness of the case. Thus, after the first encounter efforts were made to convince the study club that allowing an investigation by the researcher could be fruitful for both parties. To this end, several meetings and correspondence followed, of which the end result was that I was to conduct a study that would investigate the problems that existed with their own postal ERCS from October 1989 onwards[4]. At a later stage (starting in December 1989), I was to analyze the two available CT. Thus, more information would be provided on the nature of the problems, on possible solutions, and on the extent to which the CT would provide such solutions.

Clearly, I had a 'hidden' agenda[5] of my own, which was mainly to explore the social nature of CT-use and development. Obviously, the implicit assumption being that explicating the social nature of ERCS-related practices would shed a light on the problems that were experienced by the growers, and would at the same time contribute to the development of practical solutions.

Background: Dutch horticulture and enterprise comparisons

In the Netherlands horticultural production has developed industrial proportions. Many crops, including cucumbers, are predominantly grown in glasshouses in which climate computers are standard elements, while the use of substrate growing and computerized 'feeding' is increasing rapidly. Although most enterprises are family owned, many growers have a few regularly employed labourers and/or hire additional labour in peak periods.

Despite the seemingly industrial nature of the production process, horticulturists generally agree that individual skill and craftsmanship are important ingredients for either success or failure. Especially the ability to manage climate, as well as pruning, harvesting and crop-protection practices are considered to be crucial aspects of such craftsmanship, to which growers frequently refer in terms of "green fingers". The term "green fingers" does often have a magic connotation; it is used mainly if existing knowledge falls short in explaining the sometimes striking differences (Alleblas, 1987) between enterprise results.

> "You have to be born with it; you cannot really learn it. This also implies that you shouldn't be proud of it if you have 'it'."

Nevertheless, the widespread participation of growers in study clubs shows that they do not rely solely on their own intuition. The study clubs have a long history, in which the establishment of the Society of Dutch Horticultural Study Groups (NTS) in 1972 was an important milestone. The NTS is an extremely complex network of horticulturists[6], and its main aim is to further the technical interests of Dutch horticulturists, amongst others through the coordination, organization, support and stimulation of study club activities. At the 'lowest' level of organization one finds the so-called 'excursion-groups'. These excursion-groups normally consist of between six and twelve growers of a particular crop, who meet usually once a week with the explicit aim to openly discuss each others technical results, crop performance and practices. These meetings take place at the enterprises of the participants, that are visited according to a regular, but flexible, schedule. Thereby, an essential element for proper interpretation is the actual inspection of the crops in the glasshouse by all participants. The participants explicitly portray these meetings as occasions to exchange experiences and learn from each other. This relative openness among growers who are in fact competitors, may seem rather extraordinary. A number of elements, however, may help to clarify this situation.

First, the competitive aspirations of horticulturists are mainly directed towards the southern European countries, in which natural conditions are often much more favourable for growing vegetables[7]. Thereby they conceive the high-tech character of the Dutch production system as their main competitive advantage[8], and therefore regard technology development and effective use of available knowledge and information as a crucial prerequisite for survival. In addition to this, they see themselves as very important generators of knowledge and information. As one grower puts it:

> "Here in Holland we have at least 10,000 research stations for horticulture."

Thus, the exchange of knowledge and information among growers becomes a logical requirement for maintaining this competitive advantage. This way of reasoning is firmly supported by growers' organizations, government agencies and extension workers as well.

The rapid and continuous development of new technologies that is indeed the result of this corporate philosophy, indirectly provides individual horticulturists with another strong argument to participate in study clubs. In order to keep track of what is the newest technology, and learn how to work with it, it is crucial to look beyond the border of one's own enterprise. If one looses track of the developments, one might not even be able to speak the language of other growers in a relatively short while:

> "No, I will not adopt these computerized farm comparison systems, but I will advise my son to do so. You have to be able to talk about it. That happened with the introduction of the climate computer as well; suddenly people started talking in different terms. If you don't know what they are talking about, you miss a lot of information. If you don't participate, you won't be able to communicate after a while, and that is very dangerous."

The interest to participate in study clubs is further enlarged by the fact that horticulture can be a very vulnerable activity. Even with a climate computer, one still has to anticipate and react on constantly changing weather conditions, disease patterns, etc. Minor mistakes may have major consequences, and thus growers like to compare their own interventions with those of others, just to make sure that they are more or less 'in line'. Also, within the context of the NTS, arrangements are made that, if individual growers are in trouble as a result of technical and/or personal problems, a group of growers can be 'appointed' to temporarily supervise the enterprise under consideration; also in this way, maintaining relations with other growers is a matter of insurance and risk avoidance.

Finally, cooperation among growers is often supported by the auctioning system. Especially vegetables (e.g. cucumbers) are sold in 'blocks' of produce with 'equal' quality, that originate from different growers. At the same time the growers are obliged to deliver to 'their own' cooperative auction. Both the image of the auction and the prices paid, therefore, are, to a certain extent, dependent on the quality that is delivered by other producers. There are indeed indications that where crops are sold on an individual basis (e.g. in the potted-plants branch), cooperation and openness are less common than in the vegetable branch.

Case-study methodology and sources

During the first stage of the study, the focus was on getting both detailed information on the practices and interactions that constitute enterprise registration and comparison, and an impression of the position of this set of activities vis-à-vis others. Furthermore, it was meant to clarify the different strategies that people have developed in relation to these practices and interactions, as well as their social nature.

To this end, and on the basis of both discussions with the Registration Committee and participant observations at three excursion-group meetings, a 'questionnaire' was developed that consisted of a large number of open questions and a limited number of closed questions. Fourteen ERCS participants (28% of the total number) were randomly chosen and interviewed. In order to study the surplus value of the ERCS, and detect possibly problematic aspects, eight non-participants (31% of the total number) were interviewed as well. During these interviews that -in order to get some grip on the context- did usually start with an enterprise-walk, time was built in to divert from the questionnaire, elaborate on issues brought up by the growers, and actually sit down, observe, and participate in an effort to make sense of enterprise registration and comparison material. In relation to the 14 participants, I also had access to the summarized enterprise results (derived from the ERCS) of 1989.

At a later stage, a detailed content analysis of the two competing CT was conducted in order to adequately compare them. To this end demonstration copies and/or user manuals of these 'automated' ERCS were obtained from SITU/NTS and DACOM. Conclusions in this respect were also arrived at on the basis of observations and responses obtained during in-depth interviews with an additional ten cucumber growers elsewhere in the Netherlands, who were using one of the two packages under consideration (five of these were using the SITU/NTS package, while five used the DACOM package). The names and addresses of these growers were obtained from local extension workers.

In this second case-study, participant observations during interviews and excursion-group meetings have played a much greater role in setting the research and interview agenda than in the first. Hence, the methodological guidelines formulated in section 6.3 (or, more specifically, the guideline which proposes that it is crucial to focus on day-to-day practices) were more strictly adhered to during this study (see also section 8.1).

Unless mentioned otherwise, I will in the remainder of this chapter refer to the 1989/1990 period (i.e. the period in which the study was carried out) as 'the present', and to the enterprise registration and comparison system therein as 'the existing ERCS'.

9.2 Present registration and comparison practices and the use of the existing ERCS

In the previous section, I have already discussed some basic ideas and procedures connected with the ERCS that had been developed by the southern cucumber study club. Both growers and the auction send registration material on a weekly basis to a central address where it is entered into a database by someone who is paid by the participating growers. An (officially anonymous) overview which encompasses the registration material of all participants is then returned to the growers within one week by ordinary mail.

Within the existing ERCS growers can choose between different levels of participation. The so-called 'basic package' (the minimum level) includes mainly the registration of production results and energy use. In addition, growers can opt to register parameters concerning climate and crop-protection. Although some growers register figures in relation to labour, no opportunities for this are included in the existing ERCS. Below, I will discuss registration practices and opportunities in relation to the fields mentioned above. If necessary I will distinguish between ERCS participants and non-ERCS participants.

Production and gas: the basic package

The cooperative auction provides all growers (participants and non-participants) with registration material concerning their weekly cucumber output (numbers, quality, weights, prices, turnover, etc.). The participants' production figures are put on diskette and sent to the central address by the auction. The registration of gas (the generally used fuel for heating glasshouses) does not require a great deal of time investment by the growers either, since it only involves a weekly checking of the gas meter. Moreover, the public utility for gas provides a regular overview as well. Participants in the ERCS are compelled to provide production and gas figures (even if some occasionally fail to send in the latter). Of the non-participants 63 percent indicate that they record gas use on a weekly basis, while the rest has stopped doing so and/or suffices with the bills of the public utility. All participants agree that energy costs and production figures are crucial parameters in the existing ERCS. For a large majority of growers, these are the figures that they look at first when they receive the weekly print-out, and in many instances no additional figures are examined.

> "I spend about ten minutes at the print-out. I check a few growers on production, gas and balance. When there are major deviations in my or someone else's figures, I will start to look a bit further."

> "Still, I find the basic idea of the registration quite o.k. You get data concerning production and gas, and you can fill in the rest of the picture at the small round [the excursion-group]."

For some, the registration of production figures (even if quite extensive, see box 9.1) is still too concise. One non-participant, for example, has made a spreadsheet application in which he has registered weekly production figures for a number of years, and which allows him to make various calculations and graphs. More commonly, growers register and analyze highly detailed production figures concerning different sections in the glasshouse(s) separately (and often temporarily). These practices are usually related to experiments whereby growers try out different cultivars and/or practices on a relatively small scale.

The 'basic package' further includes the registration of feeding parameters and quantity of light. The great majority of growers pay little attention to these figures. The techniques used to measure these parameters are generally considered not to produce reliable and/or comparable results. Not surprisingly, therefore, a small majority of participants do not take the trouble of sending on these data. In some excursion-groups, however, participants have agreed to systematically keep track of these parameters.

Box 9.1: **Parameters in the 'basic package'**

Below is a list of most of the parameters included in the 'basic package'. For almost all parameters (except those relating to temperature, wind-speed and feeding) both 'cumulative' figures (that is, the added results over several weeks from the planting date onwards) and 'total cumulative' figures (that is, the added results over several weeks, including the results from previous plantings/crops in the year) are included.

- number of cucumbers yielded per square metre;
- kilograms of cucumbers yielded per square metre;
- turnover in guilders per square metre;
- number (and %) of quality I cucumbers yielded per square metre;
- number (and %) of quality II cucumbers yielded per square metre;
- kilograms (and %) of crooked and premature cucumbers yielded per square metre;
- average price per cucumber;
- average price per kilogram;
- average weight per cucumber;
- cubic metres of gas per square metre;
- cost of gas per square metre;
- balance (cucumber revenues minus gas costs) per square metre;
- litres of water provided;
- awning hours;
- quantity of light (measured in lux or Joules);
- average outside temperature;
- average wind-speed;
- EC (electricity conductivity) of water measured both at preparation and in the mat (substrate); i.e. a measure for available feeding components in the water;
- pH (acidity) of water measured both at preparation and in the mat (substrate).

Climate

In 1989, sixteen participants were using the existing ERCS for the registration and comparison of 'climate'. In practice these growers send in more than 60 parameters concerning programmed (by means of adjusting the climate computer) and/or realized climate on a weekly basis. These parameters, then, are weekly averages, and most of them can be derived from the climate computer itself. Since different climate computers work with slightly different models and data definitions it is generally considered rather useless to compare between growers with different climate computers. Thus, in the print-out growers with similar climate computers are grouped together. By implication, it does not make much sense to use the ERCS for climate registration and comparison for those who have relatively unsalable climate computers.

Maintaining an optimal climate in the context of rapidly changing weather conditions is generally considered the least tangible, and at the same time the most important, factor in growing cucumbers. As mentioned earlier, growers' abilities with respect to the manipulation of climate are often referred to in terms of "green fingers". Despite the importance of such 'feeling' for climate and plants, however, some growers apparently think that they can improve on climate management by analyzing and comparing 'hard' data. Nevertheless, the value of comparing climate figures by means of the ERCS remains disputed; four of the fourteen interviewed participants had never registered and compared climate figures in this manner, and three had discontinued to do so. The critics argue that the climate figures are about ten days old when received, which is too old to be meaningful. Moreover, these figures are averages, which means that (despite the enormous number of climate parameters) there is still a huge reduction of information.

> "Even with simple things like day and night temperatures, or ventilation and stoking practices; in reality I have divided these in four periods per day, each with different programmed adjustments. Thus, there is a lot of illusion in those figures, and you only get behind it when you discuss it in the group."

> "That climate registration doesn't tell me a great deal. Too many things remain uncertain. How is someone going about regulating humidity? On paper it all looks the same, but in reality things are done quite differently."

Besides, many argue that it is impossible to interpret climatological parameters without actually seeing the crop (see also section 9.4).

> "I can't do anything with such a heap of numbers. At a certain moment you need to see a crop. But sometimes I don't even know whose figures they are!"

Finally, a frequently expressed criticism is that measurement tools, and the location of these in the glasshouse, are insufficiently standardized for the generation of comparable parameters. In the light of these problems, three of the interviewed growers (one participant and two non-participants) had developed a different way of registering climate. They made written reports on how climate turned out in important periods, how they dealt with it, and what results followed. They maintained that this helped them to get a better and more coherent overview than simply registering data did. Similarly, I have run into a group of growers in another region who -to the same end- taped their comments in relation to their own and other growers' crops and climate. An additional three growers (who do indeed use the ERCS for climate registration and comparison as well) have bought a 'registration package' that can be linked to their climate computer. These packages allow for a more extensive storage of climatological data, and provide more opportunities for making calculations and graphical representations than the climate computer alone.

Box 9.2: **Types of parameters in the climate registration section**

The existing ERCS provides so many climate parameters that I can only provide a selection. Two basic types of parameters can be distinguished, i.e. parameters concerning the programming of the climate, and parameters related to realized climate. In relation to the former the existing ERCS includes:

- programmed day and night temperatures;
- programmed adjustment of day and night temperatures to light quantity;
- programmed times of switching between day and night regime;
- programmed time-span (in minutes) for cooling down and heating up one degree Celsius;
- programmed humidity in day and night;
- programmed adjustment of humidity to light quantity;
- programmed temperatures for starting ventilation in day and night;
- programmed influence of humidity on ventilation temperatures;
- programmed minimum and maximum temperatures of different heating tubes in day and night;

- programmed adjustment of minimum and maximum temperatures of different heating tubes to light quantity;
- programmed reaction speed of heating tubes.

Next to some climate-related parameters in the 'basic package' the climate registration in the existing ERCS includes additional parameters (weekly averages) concerning realized climate, such as:
- average realized temperatures (per day, night and 24 hours);
- average realized humidity (per day, night and 24 hours);
- average realized temperatures of different heating tubes (per day, night and 24 hours);
- average realized temperature in the mat (substrate) (per day, night and 24 hours).

Crop-protection

Eight of the fourteen interviewed participants made use of the ERCS facility to register and exchange crop-protection parameters in 1989 (while two had stopped doing so, and four had never engaged in it). An additional four growers (including three non-participants) register such parameters in their own manner.

Box 9.3: **Parameters in the registration section for crop-protection**
For each crop-protection activity, the following parameters can be registered in the existing ERCS[9]:
- date on which it was carried out;
- type of (chemical) remedy applied;
- concentration of the remedy in grams per 100 litre of water;
- quantity of water applied per hectare;
- method of application (spraying, dusting, steaming, etc.)
- duration of the crop-protection activity;
- remarks about the result of it;
- whether the treatment was curative or preventive.

Despite the fact that many growers participate in this (most recently added) registration module, many growers seem disappointed with it. Some growers have come to regard the exchange of registration material in relation to crop-protection as totally useless since it provides no guidelines for either immediate or future action:

> "What people do on crop-protection in this year has no relevance at all for the next year."

> "The diseases another grower has in his glasshouse have nothing to do with the problems that I am facing."

Others are still interested but miss important information, due in part to lack of discipline in completion of the data.

> "The data concerning the seriousness of the plague, and the results of the treatments are often not filled up, and they are far to limited anyway. As it is now, you can't do a lot with it."

Those who register material in relation to crop-protection outside the ERCS did so roughly in the same manner, and solely as a reminder for individual use. As was the case with climate registration, two growers made written reports on crop-protection activities in particular periods.

Labour

Labour registration is not included in the present ERCS. Due to projects of the extension service and a large cooperative agricultural bank, however, it is a well known phenomenon. As the use of wage labour and scale enlargement increased simultaneously, external institutions drew more attention to proper labour management and planning. Especially in this field, research and extension have developed all sorts of norms (e.g. allowed labour inputs for particular practices), which are quite generally experienced by growers as being 'severe'. Of both the participants and non-participants a majority of interviewees had experience with labour registration (eleven out of fourteen and five out of eight respectively). Half of those who had experience still kept more or less complete labour accounts. Few growers, however, registered labour on a yearly basis. In that sense the grower quoted below -a 'fanatical' registrator- is an exception.

> "I register everything. In fact, I do least with the things I get back from the study club. The labour registration really helps me a lot, especially on the side of costs. You keep working at it, and you increasingly pay attention to the small things. For example, the personnel said that the new sorting system was easier, but the figures ruthlessly show the opposite. Do things really speed up if you put in another labourer? I don't want to be forced to take intuitive decisions on that."

Most growers registered labour only in a non-permanent fashion, and dealing with specific issues, especially after making important changes in their way of operating.

> "I have tried labour registration, but the result was always the same. (...) Maybe I will have another go at it when I have built the new glasshouse."

> "I have registered labour for five years in the past, but it is a lot of work. Moreover, the results are invariably the same, namely that [in order to meet the norms] you really need to have regular personnel. Maybe I will do it once more after the rebuilding."

> "In connection with the change-over to three plantings a year I have this year registered labour as well."

Others argued that the registration of labour is a sensitive issue, which can hamper the working atmosphere.

> "I certainly could draw more conclusions if I registered labour. But I know that I employ quite a few elderly people, and I don't want to chase them."

> "I also registered labour a few years ago, but it really left me chagrined with myself and the personnel, so I wisely decided to quickly quit again."

Similarly, in some cases labour registration is less opportune.

"We work with the three of us: me, my father and my mother. Since we don't have to pay for it, we never count labour. Anyway, I am busy enough as it is, and I don't need to see on paper that I work much too hard."

The relative importance of different modes of comparison

In practice (as in the case of DELAR), the figures provided in the ERCS are used for various comparison purposes. First, figures over particular (longer or shorter) periods can be compared with figures from similar periods in *previous years*. Second, figures can be compared with the *overall averages* of other participating growers. In addition, these averages can be compared with averages from other regions in the Netherlands, which can be found in growers' magazines. Third, figures can be compared with those of *members of the excursion-group*. All but three of the interviewees regularly attended the weekly (or in some cases fortnightly) excursion-group meetings. In these meetings, growers can and do compare their figures with those of other growers in a very context-sensitive manner (either with or without explicit use of the existing ERCS). Fourth, figures can be compared with (average) figures of one or more *selected growers outside the excursion-group*; in many cases these comparisons are solely numerical and thereby less contextual in nature than those with members of the excursion-group. The most frequently made selections of growers in this respect seem to be those with high productive results. Finally, some figures can be compared with *norms* that are provided via other sources, e.g. agricultural research and extension.

Before growers were asked to elaborate more freely on the relative importance of the various comparison opportunities, they were confronted with several closed questions. First, they were asked to indicate the importance of each opportunity on a four point scale (1 = 'not important', 2 = 'moderate importance', 3 = 'important', 4 = 'very important'). In terms of the resulting average scores, the comparison opportunities can be rank-ordered according to importance in the following manner:

Table 9.1: Average importance of each comparison opportunity on a four point scale (average rank-ordering within brackets).

	all growers (n=22)	ERCS participants (n=14)	non-ERCS participants (n=8)
previous years	(1) 3.1	(2) 3.1	(1) 3.1
members of the excursion-group	(2) 2.9	(1) 3.2	(3) 2.4
overall averages	(3) 2.6	(3) 2.6	(2) 2.6
selected growers outside the excursion-group	(4) 2.3	(4) 2.3	(4) 2.3
norms	(5) 1.7	(5) 1.7	(5) 1.8

Subsequently, growers were asked to indicate what they considered to be the 'most important' mode of comparison (see table 9.2).

Table 9.2: Number of growers who label a particular mode of comparison as the 'most important' (average rank-orderings within brackets).

	all growers (n=22)	ERCS participants (n=14)	non-ERCS participants (n=8)
previous years	(3) 4	(2.5) 3	(4.5) 1
members of the excursion-group	(1) 9	(1) 7	(2) 2
overall averages	(4) 3	(4) 1	(2) 2
selected growers outside the excursion-group	(2) 5	(2.5) 3	(2) 2
norms	(5) 1	(5) 0	(4.5) 1

The different position of especially 'comparing with previous years' in the two rank-orderings (relating to all growers) is associated with the fact that the answers given in relation to the first set of questions are bi-modally distributed for the valuation of 'comparing with members of the excursion-group', whereas this is not the case for the valuation of 'comparing with previous years'. The valuation of 'comparing with previous years' ranges from 'moderate importance' (n=4) to 'very important' (n=6), while five growers (four of which are non-ERCS participants) value 'comparing with members of the excursion-group' as 'not important' and eleven consider this type of comparison as 'very important'. Due to the fact that growers quite consistently evaluate 'comparing with previous years' as '(very) important', it emerges as the most important type of comparison in table 9.1, while only relatively few growers *explicitly* label it as the 'most important' (see table 9.2). Apparently, the differences in opinion concerning the value of 'comparing with members of the excursion-group' is somehow connected with participation or non-participation in the ERCS. In section 9.4 the differences between different categories of growers will be analyzed in more qualitative terms. At this point suffice it to say that (as was the case with dairy farmers in the first case-study) different growers seem to prefer different modes of comparison.

9.3 Characterizing diversity among southern cucumber growers

Before discussing diversity among cucumber growers in the southern study club, I must emphasize that they constitute a rather particular group of growers. As is implied by the official name of the study club ('Stoke-Cucumber Study Club Brabant/Limburg') all growers in this club have adopted a particular technological package, which centres around the use of substrate and the heating of the glasshouse with a central stoking-unit and heated water tubes (which at the same time are used as rails for transportation trolleys). Thus, these enterprises are characterized by lay outs, practices and technologies that are rather different from those in more conventional enterprises, in which growers use hot air canons for heating and (in many cases) plant their crops in the soil. In fact, these differences are so extensive that they have stimulated (and legitimized) the establishment of a separate 'stoke-cucumber study club', next to the 'hot-air-cucumber study club'. However, although the growers under investigation already belong to a particular sub-category, my study shows that even within this group there is considerable diversity.

As is the case with other agricultural branches, horticulturists are frequently classified in terms of 'frontrunners', 'followers' and 'laggards', and even within the stoke-cucumber study club, growers and extension workers use these labels (especially 'frontrunners' and 'followers'). As an alternative, Spaan & Van der Ploeg (1992) have developed a classification of styles of farming in horticulture along two dimensions, i.e. 'integration in markets' and 'speed of technology adoption' (1992:9). The main categories distinguished by them are 'Top Growers' (Toppers), 'Real Growers' (Echte Tuinders) and 'In-Betweeners' (Middenmoters). On one end of the extreme, the Top Growers are (roughly speaking) described as specialized growers, who tend to grow on substrate and who invest heavily in new technology with the view of producing as much as possible per square metre (Spaan & Van der Ploeg, 1992:6). In contrast, Real Growers are far less specialized, tend to grow on soil and make much more use of own labour and craftsmanship (or 'l'art de la localité') rather than of technology. (Following my discussion in section 5.1, I will argue in section 9.8 that this strict separation between technology use and craftsmanship is rather misleading).

In terms of this particular classification of horticultural styles, I would no doubt have to classify virtually all members of the stoke-cucumber study club as Top Growers. Thus, using this latter classification would leave little room for discussing diversity within the group of horticulturists under investigation. Furthermore, one of the conclusions derived from chapter 8 (see section 8.6) is that -in the context of CT-development- it makes sense to explore dimensions and/or methods for classification that are more directly 'knowledge-related' than scale, intensity, speed of adoption and/or orientation towards the market, and technology. Hence, neither of the two presently used classifications seem appropriate for my purposes.

Intermezzo: the prospects of using Kolb's typology of learning styles as a basis for analyzing diversity

It might be considered possible to use Kolb's theory of experiential learning (1984), and particularly his distinction between different learning styles (accommodators, divergers, convergers and assimilators) as a starting point for making an alternative classification. Although others have adopted this classification (see e.g. King et al., 1992; Bink, 1993) for such purposes, I have abandoned the idea for several reasons.

My objections and doubts are both theoretical and methodological in nature. Kolb's typology of learning styles originates in his model of experiential learning in which stages of 'concrete experience', 'reflective observation', 'abstract conceptualization' and 'active experimentation' iterate in a cyclical manner (1984:42). Although Kolb's conceptualization of these stages suffers from a certain amount of methodological individualism, it is certainly an interesting 'sorting scheme'. However, Kolb takes it much further than that, and claims that these four stages can be associated with two structural dimensions of learning processes: (1) grasping via apprehension versus grasping via comprehension[10] and (2) transformation via extension versus transformation via intention[11] (see Kolb, 1984:43-60). In relation to learning styles, the extremes on the prehension dimension can be characterized as 'orientation towards concrete experience' (*feeling*) versus 'orientation towards abstract conceptualization' (*thinking*), whereas on the extension/intention dimension the extremes are 'orientation towards active experimentation' (*doing*) versus 'orientation towards reflective observation' (*watching*).

The italicized words are the sample words which Kolb uses in his Learning Style Inventory (LSI) test (1984:68-69). By means of this test, individuals can be located in a two dimensional space, whereby they can be identified as divergers (relatively high on 'feeling' and 'watching'), assimilators (relatively high on 'watching' and 'thinking'), convergers (relatively high on 'thinking' and 'doing') or accommodators (relatively high on 'doing' and 'feeling'.

On the basis of my theoretical framework (and personal experience and intuition), I especially find the *opposition* between learning by 'feeling' and learning by 'thinking' to be rather debatable. From my conceptualization of knowledge (see chapter 5), it follows that 'concrete experience' and 'abstract conceptualization' are closely intertwined in that such experiences are only imputed with meaning on the basis of larger frames of meaning that are embedded in actors' life-worlds. Hence, it can be argued that the experiencing of apprehensions and intuitions involves, at the same time, an abstract conceptual process. Of course, the extent to which actors are -at a particular point in time- discursively aware of different aspects of this process may differ, but, in my view, this does not justify the fundamental opposition made. Moreover, apart from methodological objections that can be raised in relation to the questions in the LSI-test[12], their decontextualized nature[13] seems to imply that a learning style is seen as a stable characteristic, which can be associated with an actor in different social contexts. This suggests not only that -given a particular identity (e.g. the actor as farmer)- one's learning style does not change from context to context, but also that this style is the same for all the different identities which may constitute an actor (e.g. a scientist, a farmer, an amateur photographer, a mother, etc.). Starting from a constructivist perspective, however, one would expect that an individual's 'learning style' may vary from context to context, and is shaped in social interaction with others.

Towards practice-based classifications

The above elaborations brought me to the more general insight that I should not again resort to using theoretically informed dimensions for classification that originate outside the direct empirical context and problematic. Inspired by my theoretical framework, I decided not to focus on dimensions and/or general orientations, but instead try to ground my classification of diversity directly in diverging *practices* (and/or evaluations of these) that are either constituent elements of an activity/practice at a larger level of abstraction (in this case enterprise comparisons), or closely intertwined with it.

It will appear in section 9.4, that -starting from enterprise-comparison-related practices- I arrived at *several* classifications of diversity, for example:

- Technical Fine-Tuners and Strategic Evaluators;
- ERCS participants and non-ERCS participants;
- Quantity Growers, Quality Growers, and Intermediate Growers.

9.4 Social practice, diversity and the development of criteria for CT-design

Starting from various classifications of diversity, this section presents the results of my in-depth study of the social practices and interactions related to enterprise registration and comparison, and growers' rationalizations in relation to these. On the basis of these it appeared possible tentatively to formulate practical design-criteria that any Enterprise Registration and Comparison System (be it partly computerized or not) would have to meet, in order to be acceptable and applicable to the rather diverse group of growers that constitute the southern stoke-cucumber study club. These criteria (relating to both internal and external design) will be listed along with a thematic presentation of the empirical results.

Grasping the context: the different information needs of Technical Fine-Tuners and Strategic Evaluators

I have investigated whether it was possible to make a sensible differentiation between growers that expresses different priorities with regard to the various comparison opportunities that exist (see section 9.2). On the basis of my experiences during qualitative interviews, it appeared indeed possible to distinguish roughly between two categories of growers.

The first category of growers tends to look at enterprise registration and comparison as an activity that should support them in their everyday practices and interventions in relation to the growing of cucumbers (i.e. in relation to the management of climate, crop-protection, etc.). These are the growers that grant particular priority to making contextual comparisons with members of the excursion-group. The following quote is typical for these growers, which I refer to as *Technical Fine-Tuners* (n=9; see table 9.2):

> "I want to get a detailed insight in *how* people arrive at a particular climate. In my opinion, for example, production is determined between 5 and 10 o'clock in the morning; that's when the crop is activated, and *that* is what I want to talk about. I would like to know what happens with the heating tube temperature between 5 and 10 o'clock, and how that is related to climate computer settings, light availability, and the temperature in the glasshouse. In order to find out, weekly or annual averages have no meaning, because you can realize a temperature of 20°C with open or closed windows. In fact, you need data on one particular day, and you then have to talk about it in order to know what someone else is doing. Therefore, the only comparisons that are relevant to me are those with the excursion-group. The data only serve as something to talk about; they have no other value. I once visited a group that only talked about figures, and not about crops. I can't see any use in that."

In contrast, a second category of growers perceives registration and comparison activities as mainly beneficial for deciding on tactical and strategic issues. Such issues include the sensibility of: (a) building a new glasshouse; (b) changing over to a different crop or cultivar; (c) changing the planting dates and/or the number of cultivations per year, etc. These are the growers who either emphasize the importance of comparing with their own enterprises in previous years, or have a special interest in comparing with figures that cannot be easily linked with detailed context information (i.e. those who give priority to comparing with overall averages and/or selected growers outside the excursion-group). These growers will be labelled as *Strategic Evaluators* (n=12, i.e. 4+3+5; see table 9.2). One of them argues:

> "The most important thing is to compare with the group averages. You have to know whether you are more or less in line. I don't need to know who is behind the figures, because it is not important. If you know it, you never stop reasoning. (...) I have never changed my technical operations on the basis of registration and comparisons; you cannot take long term decisions on

that. What I did do, however, was to make an annual plan with the registration print-outs in my hand: Is it wise to plant two or three times a year? Do I grow cucumbers or tomatoes? Does it pay to do away with the old glasshouse? With those aggregated data you can make such a plan, and take it with you to the bank as well."

Clearly, the comparison interests of growers can vary considerably from context to context, and no grower can escape having to deal with both technical and strategic issues. In a particular situation, matters of technical fine-tuning can be of major concern, whereas in other situations strategic issues predominate. Nevertheless, from the interviews, I gained the impression that the interest in technical or strategic issues is a fairly stable characteristic. That is, growers show a rather clear preference for dealing with either technical or strategic questions, and they even tend to define their problems in corresponding terms. Apart from qualitative evidence in relation to this, there are also some more quantitative indications that we are indeed dealing with fairly stable differences and/or distinct categories.

First, it may be that those who state that they find comparing with 'selected growers outside the excursion-group', 'overall averages' or 'previous years' the most important (see table 9.2), have larger enterprises than those who emphasize the importance of comparing with 'members of the excursion-group' (12,260, 12,867, 12,275 and 9,562 m^2 respectively; $F = 0.66$; $p = 0.58$). Since scale enlargement in the horticultural branch has been stimulated by several parties and in various manners, this seems to indicate that strategic considerations may indeed have guided the former groups of growers (i.e. Strategic Evaluators) to a relatively significant extent. This picture is partly reinforced[14] by the fact that especially in the smaller enterprises (in contrast to the larger ones), growers tend to aim at producing *quality* rather than *quantity*. Since even quality growers agree that quality products are not properly compensated at the auction, it seems again that 'technical' arguments (relating to the 'internal' rather than the 'external' environment) prevail over 'strategic' ones (see a later section for details on this issue).

Furthermore, the Technical Fine-Tuners seem to have a very limited interest in getting registration material from growers outside their own region; 89 percent of them show no interest at all, versus 33 percent of Strategic Evaluators. As will be elaborated upon shortly, such material is indeed only useful for supporting strategic decision making. The interest of Strategic Evaluators in figures from outside the region is also reflected in the fact that they are much more in contact with commercial (as against public and/or cooperative) extension workers (75% has a fixed contract with them, versus 33% of Technical Fine-Tuners[15]). Many growers view commercial extension workers as people who bring in experiences from 'the outside':

"The commercial extension has a wider orientation. These guys have clients in the Westland and in Belgium as well, so that they can tell stories from growers outside the region."

"I used to be with the regular extension service, but I have changed since I would like to hear some different ideas now. Besides, our new man knows a bit about tomatoes as well, especially if it comes to diseases [a small proportion of members of the cucumber study club grow tomatoes at a particular time of the year, CL]. Technically speaking I don't need such a man, for I rarely have disease-related problems. The consequence is that I don't know a lot about it, and with the commercial extension service I make sure there is a bit of exchange now."

Some growers, however, are in the 'lucky' position that they do not need to pay for outside experiences:

> "We have a few very active members in the excursion-group. Luckily, one of them has a slipped disc, and he has the time to travel all over the country."

The differential prospects of the existing ERCS for discovering the relevant context
Both Technical Fine Tuners and Strategic Evaluators frequently indicate that figures have value only if they can be put in the right context.

> "You have to see, see, and see once more; you cannot rely on just words and figures."

> "You must know what type of man, and what sort of enterprise is hidden behind the figures."

Similarly, it emerges that for both categories the relevant (context) information changes over time. Not only are there specific points of interest for different periods in the production cycle, but there are also indications that issues change from cycle to cycle and from year to year. This apparently relates, for example, to: (a) newly introduced technological innovations (new types of climate computers, biological crop-protection, etc.); (b) new governmental policies and environmental regulations (the banning of particular chemical remedies, changes in nuisance act regulations, etc.); (c) market developments (e.g. increasing competition from Southern European countries); (d) public opinion and concern (e.g. relating to the presence of chemical residues in vegetables); and (e) new questions and curiosity arising from past experiences.

Already from the first two quotes in this section, however, it emerges that -given their different interests- Technical Fine-Tuners and Strategic Evaluators tend to look for rather different *types* of context information.

The *Technical Fine-Tuners* are -in relation to the figures provided in the existing ERCS- primarily interested in the day-to-day interrelations between climatological parameters, crop-protection practices and production results. Thereby they wish to unravel in detail by means of which practices and interventions these weekly averages were arrived at. To this end, they stress the critical importance of seeing the enterprise, watching the crop and talking to the grower.

> "Before you can say anything sensible you need to know what type of glasshouse someone has, how it is situated, how many tubes are used for heating, etc. To measure is to know, but you have to know a few things even before you can measure."

> "Those figures are all very nice, but you can't really conclude what is wrong. I can see that I am always lagging behind in the beginning of the season, but you can't derive why from the figures. Therefore you need to dig deeper."

> "The most important thing is to know *why* someone does something. For example, one can have very good reasons for stoking harder, but I can't see that from the paper."

For the Technical Fine-Tuners, therefore, registration activities are closely connected with discussions in the excursion-group.

"There are a lot of things that you cannot express in a figure, so it is better to sit together and talk."

Nevertheless, it was striking to see that not a single reference was made to the existing ERCS in any of the observed excursion-group meetings. At closer investigation, the existing ERCS has several characteristics which impedes its use in these contexts:

(1) Officially, the system is anonymous; that is, on the print-out specific enterprises are identified only by means of an enterprise number. Although in practice most participants know the corresponding names, it is not easy to get a good comparative overview of the excursion-group since their registration material is scattered over the print-out.
(2) It was not acceptable for the ERCS to serve as a starting point during excursion-group meetings, since the groups were composed of both ERCS participants and non-ERCS participants.
(3) The figures provided in the existing ERCS are only weekly averages, and therefore of limited interest to Technical Fine-Tuners.
(4) Although specific excursion-groups appear to have their own particular interests, the existing ERCS does not provide the opportunity to register special parameters per excursion-group.
(5) At the time when ERCS print-outs can be discussed in the excursion-group, the parameter values that are included in it are almost two weeks old. Technical Fine-Tuners, however, are much more interested in discussing the current issues and problems, which are of more direct relevance to them, and for which adequate context information is actually available.

Although the limited compatibility between the design of the existing ERCS and the functioning of the excursion-groups significantly hampers the use of the ERCS, the opposite cannot be maintained. As I will show later on, growers are quite satisfied with the functioning of the excursion-groups. Moreover, during excursion-group meetings, growers have no shortage of quantitative material since they carry the most recent figures 'in their heads', and have developed ways to exchange these orally. In most excursion-groups the figures of the visited enterprise(s) at least are read aloud, whereby the visitors write them down on a specially designed form.

For their specific purposes, the *Strategic Evaluators* seem to have fewer problems with the existing ERCS. It seems that the context information that they are looking for is more concrete, and more easily provided than that which the Technical Fine-Tuners wish to have. This relates to the longer time horizon that is inherently connected with strategic issues, and which causes relevant context information to be of a broader nature.

"I look especially at the average prices of previous years, and at my own production. When you see that prices went up during particular periods in previous year, you need to adjust your production accordingly."

"You know, for example, that someone always stokes pretty hard; in retrospect you can look whether that is worthwhile or not."

The next quote illustrates that context variables relating to the size and type of glasshouse(s), type of glass, stoking capacity, awnings and cucumber cultivars, are important to Strategic Evaluators.

> "Deciding to tear down an old glasshouse is not so easy. For some time, I have therefore registered the production from the different glasshouses separately. I also compared with other growers, and thus I was able to calculate that it would indeed be profitable to replace the old section. I also changed my planting dates; I try to be among the first now. When you plant later you can in principle reach the same production level as those who are early, but only if you are a top grower. When something goes wrong when you are early, you can still end up around the average. The consequence of my type of glass is that I always have a bit of a setback during the summer. An older crop suffers more from that than a young one, since a young crop has different needs. Therefore, I think that -with my type of glass- it is profitable to plant three times a year. That is a theory that I have developed on the basis of the registration."

This type of context information can be quite easily retrieved since it is exchanged among ERCS participants at the beginning of each year (see box 9.4).

Box 9.4: **Parameters provided as context information at the beginning of each year.**

- the number of glasshouses and their size;
- several indicators for determining the type of glasshouse and its lay out;
- several indicators in relation to the type of glass (width, double/single, etc.);
- the type of awning facilities;
- stoking capacity;
- several indicators relating to the number and types of heating tubes;
- sowing dates and planting dates;
- cultivar of cucumber used;
- cropping system (growing 2 or 3 times per year);
- the number of crop strings;
- the number of plants per m^2;
- planting costs;
- etc.

Similarly, despite the official anonymity of the ERCS, it is not difficult to get hold of the names that correspond with the enterprise numbers. This is important, since Strategic Evaluators like to know to what 'type' of grower the figures originate from.

> "You try to find out whether or not you are lagging behind; that is the whole idea. If you think someone can do better you try to learn something. Thus, you must know more or less whose figures you are dealing with, what type of man you are talking about, and what the enterprise looks like."

Furthermore, the cumulative figures which are included in the existing ERCS fit in quite neatly with the Strategic Evaluators' wish to compare over longer periods of time. In all, it follows that Strategic Evaluators' registration activities are much less closely connected with excursion-groups than those of Technical Fine-Tuners (which is indeed why they have fewer problems with the existing ERCS).

> "When I look at my group, at how it all turned out, I think there was no need for me to walk with them. There was no spirit for looking at the figures. In don't need to see the crops; I can see enough from the figures."

> "The big advantage is of course that with all those figures you really get decades of experience at one blow."

Criteria for CT-design
On the basis of above analysis, five tentative criteria for CT-design can be formulated. First, the parameters included in any system supporting enterprise registration and comparison should anticipate different types of growers (design-criterion 1). Second, for any ERCS to be useful for a considerable number of growers, there needs to be a close link between the ERCS and the excursion-groups. This has direct implications for the presentation and lay out, group composition, arrangements in relation to anonymity, etc. (design-criterion 2). Similarly, the ERCS should -in order to facilitate 'strategic comparisons'- not only provide weekly performance parameters, but also supply additional context information on the broader circumstances (type of glasshouse, stoking capacity, etc.) which characterize each participating enterprise (design-criterion 3). Fourth, provisions should be made for individuals or excursion-groups to exchange parameters that only *they* are interested in (design-criterion 4). And -last but not least- technical, financial and organizational conditions should be met in order to allow flexibility of the system through time, so that new information needs can be included rapidly (design-criterion 5).

It is important to note that it cannot be firmly concluded that an ERCS should necessarily exchange registration material in a very fast manner. I have shown that: (a) those with a strategic interest work with parameters that are aggregated over a longer period so that exchange speed is irrelevant, and (b) that those with a technical interest can do little with figures only, and have found ways to exchange up-to-date registration material orally. For them the only advantage of faster exchange is that it would -at least in theory- allow for a better preparation of the meetings. Clearly, this brings into question the whole idea of supporting enterprise comparisons by means of CT, since from the outset the major advantage of using such a technology was thought to be the speed with which registration material could be exchanged.

Drawing conclusions: the fuzzy nature of learning

My last comment brings me to the initial expectations that were associated with the introduction of the existing ERCS. As mentioned before, growers had developed the ERCS in the expectation that it would enable them to draw more general conclusions; a wish that can probably be traced back to a partial adoption of scientific rationalities and ideologies. From observations and discussions with growers, however, it appears that, even with supposedly reliable production figures and relevant context information, it is extremely difficult to draw conclusions of any type.

When comparing the registration material, growers are constantly trying to explain and justify the differences that they encounter. Usually, however, they find an abundance of context variables that may be relevant in explaining particular differences. Therefore (and even if Strategic Evaluators are slightly more successful in this respect than Technical Fine-

Tuners) very few growers can actually pinpoint specific conclusions that they have drawn on the basis of the registration and comparison of data. (As I have elaborated in box 2.4 in chapter 2, a horticultural research institute has not been very successful in this respect either.) Thus, some of the growers were disappointed, which resulted in relaxation in their discipline of sending in registration material and the subsequent disappointment of those whose expectations had not been as high. Nevertheless, growers indicate that they learn a lot from excursion-groups.

> "You learn a lot in the small groups, especially in relation to the judgement of the crop and the climate. However, it is never so clear that you can intervene at once; you can only learn for the future. Intervening is never right; you always have to sleep on it for one or two nights. Sometimes I do indeed change the climate-computer settings when I come home from the excursion, but in those cases it often happens that I put it back again after half an hour."

Apparently, the process of enterprise registration and comparison is a very slow and gradual collective and individual learning process:

> "There are many things that I do, without knowing exactly where they come from. It is all very gradual."

> "Sometimes I come back from the excursion-group thinking that I didn't get any wiser. Much later it may come back, and I start thinking about it again."

> "It isn't really clear what you get out of it. Maybe you pick something up here and there. It doesn't guide you in taking big decisions; that holds for building a new glasshouse as well. Only when I am in doubt I will have a look at the print-outs. (...) On the basis of the small group, I sometimes decide to adjust the climate; that is a small decision, but it sometimes has major consequences. (...) One conclusion that can be clearly drawn, is that the light meters are not right"

This latter quote points to another drawback for drawing conclusions (which I have already touched upon in section 9.2), namely the lack of standardization in climate computer models, measurement tools and procedures. Hence, one grower argues:

> "If growers cannot generally provide accurate figures on certain issues, we should not write them down at all. My climate computer, for example, can calculate the average temperature over a 24 hour period, but it cannot split it up into average day and night temperatures. Similarly, there are growers that do not measure water, since they get it from the ditch."

Another bottleneck in this respect is that it is difficult in the postal ERCS to correct the print-outs of all participants when individual growers in retrospect discover that they have accidentally sent on faulty data. Similarly, the reliability of production figures -although provided by the auction in a standardized manner- can be unreliable in various ways as well; in some of these the black market plays a role.

> "During the summer comparing was not interesting for us. The old glasshouse was empty, and in the new one we were still cutting. Thus, the averages per square metre turned out to be very low. Of course you know yourself why that is, but there are many growers that do not know."

Another grower confesses:

"I sell a lot of cucumbers at home [thus avoiding the auction and taxes, CL], and that is not allowed. Thus, the comparisons are not as meaningful as they could be. For me the data are really valuable, but others are led to believe that I am doing badly. In fact, the others do not get back from me what they should be getting, because I try to be silent about it. Thus, I participate for my own good only. There are others that don't participate because of their sales at home. I feel very bad about it at times as well."

I will return to the issue of black market activities at a later stage. For the moment the following additional criteria for CT-design can be formulated:

First, in order to improve the scope for drawing conclusions, any ERCS should include regulations, arrangements and sanctions concerning measurement procedures and the calculation of parameters that either: (a) guarantee sufficient validity and/or reliability of parameters, or (b) give growers a good indication of the ways in which reliability and validity are violated (design-criterion 6). To the same end, it would be wise to provide clear procedures and opportunities for correcting faulty parameters (design-criterion 7). Furthermore, it can be argued that any ERCS should, apart from being presented in a realistic manner (design-criterion 8), be designed to accommodate *gradual learning processes*. Thus, facilities for easy retrieval, selection and 'playing around' with registration material may be useful (design-criterion 9). As I will elaborate later, computers have certain advantages over paper in this respect (see section 9.6). However, other tools could be of help as well. As I have mentioned in section 9.2, some growers and excursion-groups have started to tape their own comments and conversations while inspecting their crops. Thus, they are able to record and retrieve a large number of thoughts and evaluations, which clearly has a qualitative advantage over storing already available registration material in a computer. Finally, in order to guarantee discipline, an ERCS needs to be accompanied by certain sanctions against those who repeatedly fail to send in their parameter values (design-criterion 10).

ERCS participants, non-ERCS participants and the relative importance of the existing ERCS

At several points in my analysis, I have already come across other sources of information than the existing ERCS to which growers pay attention. Such sources include, for example, the public extension service, 'the Society' (a socio-economic extension service provided by farmers' unions), commercial extension services, sales representatives, magazines, employees, and the auction.

No systematic study was conducted on the relative importance of these sources. I have, however, asked growers to rank-order the different study club activities in order of decreasing importance. These activities include: (a) the excursion-group meetings (or 'small round'); (b) the 'large round'; that is, meetings whereby all members of the study club are invited to visit an enterprise that -for one reason or another- is of specific interest at a particular point in time; (c) the winter meetings (usually held in a public house), at which extension workers and/or researchers are asked to elaborate on a particular theme; and (d) the existing postal ERCS. Given differences in experience with the existing ERCS, it seemed relevant at this point to differentiate between those who participate, and those who do not.

Table 9.3: The relative importance of study club activities for ERCS participants and non-ERCS participants, expressed in average rank-numbers

	ERCS participants (n=14)		non-ERCS participants (n=8)	
the 'small round'	(1)	1.0 (unanimous)	(2)	2.1
winter meetings	(2)	2.3	(1)	1.9
the postal ERCS	(3)	3.1	(4)	3.7
the 'large round'	(4)	3.6	(3)	2.4

It is striking that all ERCS participants (Technical Fine-Tuners *and* Strategic Evaluators) appreciate the excursion-group meetings most. On average, the non-ERCS participants (mainly Strategic Evaluators, see table 9.2) are less positive, but if we abstract from the four (out of eight) among them who do not participate in excursion-group meetings at all, the 'small round' is still highly valued (average rank-number = 1.5). For the large majority of growers (again excluding the four growers that participate in neither the ERCS nor the 'small round'), the motivations in relation to the valuation of different study club activities can best be summarized as follows.

the 'small round': "You still learn the most from growers."

the winter meetings: "Important to thoroughly discuss a specific subject in the presence of extension workers and researchers."

the postal ERCS: "Sometimes nice, but the benefits are too limited."

the 'large round': "The group is far too large, and thus it is difficult to talk to each other. Moreover, there is often no clear subject to talk about."

In all, it can be concluded that one should not overestimate the importance of the predominantly numerical registration and comparison activities which are inherently connected with the existing postal ERCS. Even if the existing ERCS could be considerably improved (e.g. through a closer connection with the excursion-groups and/or the provision of 'playing' facilities; see earlier formulated design-criteria) we do wise to remain cautious in this respect. In qualitative terms, this conclusion is underlined by the rather tepid responses of growers in this respect.

> "Yes, I indeed study the data. And after that I go back to normal, and grow cucumbers again"

> "You have to look at it as a sport: you don't earn anything from the registration only. In Vegetables and Fruit [the growers' magazine] it is said that if you are doing the registration well, you could know for certain which cultivar to use. That of course is nonsense; you can only say something like that after a thorough discussion with someone who has experience."

> "We never really talk about it. When they raise the fee from fl. 350.- to fl. 400.- I think everybody will stop; myself included."

Competitiveness, black markets, geographical isolation and the moving around in different social networks

In the light of the foregoing, I found it of interest to further explore potential differences between ERCS participants and non-ERCS participants.

Horticultural extension services, and other institutions have in the last decade stressed the importance of registration as a means to get a better grip on one's enterprise. The general image that ERCS participants have about non-ERCS participants is that they do not register figures apart from those that they automatically get from auctions, bills, etc. Although this image seems true for a minority of non-participants, I have shown at several points in section 9.2 that the majority of those that do not participate in (elements of) the present ERCS are nevertheless involved in various registration and comparison activities. Two of them even register extremely extensively; one with the help of a spreadsheet program and a word processor, and the other with a climate-registration package and manually drawn graphs. The former argues:

"Who writes will stay, who prints will win."

Also from other angles it appeared misleading to characterize these enterprises as being somehow 'less sophisticated' or 'less developed'. On average their enterprises are only slightly smaller than those of ERCS participants (10,388 m^2 versus 11,640 m^2). Similarly, their glasshouses seem equally 'modern' as those owned by participants. From the average age of the newest section it emerges that most non-participants have built a new glasshouse around 1985, whereas ERCS participants have last built a new section around 1983. For both categories, the oldest sections originate from around 1976. Also, there seems to be no 'generation gap' between the two categories; the non-participants are on average 43 years of age, versus 40 years for participants.

Non-participants themselves express a variety of reasons for their non-participation. A minority of them refer to reasons that relate to the difficulties in the interpretation of registration material and the lack of context information (see earlier on), or to matters of health and time.

"For me it is predominantly a lack of time. (...) Especially if you are short of labour anyway, the registration is the first thing to drop. I ordered a test now; in fact I want to know exactly what the production of those plants is going to be. Even for things like that I can barely find the time. So I spend my energy on that, rather than the weekly registration. Besides, I have been needing spectacles for four years now, and as a result of an eye abberation I find it very difficult to get used to that. Thus, I read less than I would like to; computer screens and print-outs are a problem for me."

"I have started with the cultivation of stoke-cucumbers only this year. I really have my work cut out with trying to get to know the climate computer and the new glasshouse. Next year I would like to participate, but this year it is a madhouse already."

One of the two non-ERCS participants that did participate at an earlier stage implicitly refers to the rat race which I will discuss next.

"I have always been a very tough worker. I was always expanding and investing, and for a while that has put me into financial trouble. I always wanted bigger, and then I ended up in hospital. Well, once you are lying in intensive care you start to look differently at your life and work. In hospital I found out that I only missed the small group, and not the rest. I didn't miss the registration either. When I was able to go back to work I dropped it all; I no longer have the urge to participate in everything."

Most non-participants have more 'political' reasons for not participating. Quite a few growers feel unhappy about the *competitive atmosphere* which surrounds the existing ERCS. Indeed, even if -as I have elaborated in section 9.1- in many ways enterprise registration and comparison expresses the growers' genuine wish to cooperate, there are significant competitive connotations as well. Growers use a specific variable in order to measure success, which is the cumulative amount of guilders turnover per glasshouse square metre. Even though they see the relative value of this parameter, growers that do best in this respect tend to be highly respected and treated with caution. Those who do not well in these terms are looked at with a certain amount of pity and suspicion. Thus, for those who -for a variety of reasons- tend to have relatively low production figures, participation is not all that attractive. The following quote is derived from the other grower that discontinued participation.

"In the beginning I could really see it work. But now I feel that differences between glasshouses are insufficiently recognized and accounted for. Personally, I have built a glasshouse with double glazing, which means that I have less light. The result is that I am slightly lagging behind in production. I just don't like to be always at the bottom end; you are all the time left with the impression that you are the worst grower. Besides, the system does not correct for differences with regard to the quality of employees. (...) In addition to all this, I used to be the one that planted earliest, which meant, on the one hand, that everybody knew me, and on the other, that my figures were always printed right at the top of the list. Thus, there was no anonymity. If it had all been a little more unknown, I wouldn't have had so many problems with it."

A participant confirms:

"In fact, all what is left is a competition. I have thought about quitting. If I am not on top, I am not satisfied. It keeps you active, but it costs me a lot of my life. It is really killing. For me personally those young and highly educated growers function as a stick behind the door."

Not surprisingly, given this context, there is a certain amount of distrust and gossip about growers trying to inflate their production figures.

"There are still rumours going around that some growers have not given precise figures concerning their acreage. This would explain why they are doing so well per square metre."

"With the figures I get from the auction I have plenty of data to get an overview of my relatively small enterprise. I don't need more data. Besides, they are turning the whole thing into a competition. I hear that there are people who buy production from others, which they then bring to the auction again only in order to be on top ... it is crazy. In the small groups we have access to the same data, so what is the point of making such an expensive system? The whole show of getting production figures via the auction has in fact arisen from mutual distrust. Those who are at the bottom of the list may not even be able to have a decent night's sleep."

Some non-participants explicitly mention that they illegally sell produce (avoiding the auction) and that they evade taxes on labour. On top of the fact that this reduces their performance in terms of productive results (at least as accounted for on the ERCS print-out), they are obviously concerned that others (e.g. fiscal authorities) may find out about their illegal practices. Thus, they are extremely careful in providing others with registration material since: "One never knows where it ends up."

> "I don't think it is of much use. I walk through the glasshouse and I have the private extension worker; that is enough for me. If I need extra temperature, I need it, and then gas is certainly not a restricting factor; why then would I keep track of it all? Moreover, I get a lot of data from the auction and in my yearly accounts I can see what I spend on crop-protection. (...) Furthermore, it is impossible for me to get regular personnel, and part-timers are only interested if I pay them black. Of course, I need to get the money to pay them black, so I sell cucumbers outside the auction. My accountant always tells me: "Make sure that your data do not wander off." And I think he is quite right."

As I have illustrated in the previous section, non-participation in this context may also arise from feelings of guilt, i.e. the fact that fellow growers are provided with misleading information. The grower quoted below makes an interesting connection between geographical location and illegal practices.

> "To start with, I think a lot of data are incomparable. Especially in relation to climate, registration is problematical. It is impossible; you can only improve on it by talking about it. Thus, the small group suffices for me. The most important reason that I do not participate, however, is that a lot of my stuff is sold outside the auction. My enterprise is slightly outside the centre, so I have better opportunities to do so. I am talking about several guilders per square metre, so you really have to protect yourself."

At closer investigation it appeared that a relatively large percentage of non-participants live outside the five enclaves[16] where the majority of stoke-cucumber enterprises are concentrated. Of the 54 enterprises belonging to ERCS participants, 48 percent are located in a relatively peripheral area, whereas for the 26 non-ERCS participants this is 69 percent. Thus, although some participants also indicate that they are involved in illegal practices, many non-participants are in fact in a better position to 'secretly' bring in a German truck to illegally export produce.

In all, the impression emerges that some of the non-participants (and especially those four (50%) that do not participate in either the existing ERCS nor the excursion-groups[17]) are not only isolated in geographical terms, but also -within the study club- in social terms. They see enough advantages in being a member of the study club, but they have reasons to remain relatively passive and 'low profile'; i.e. they 'marginalize' themselves and/or they are 'marginalized' by others.

Nevertheless, it would be mistaken to characterize these growers as 'socially isolated' altogether. Although no systematic inquiry has been undertaken, there are indications that they 'compensate' their limited participation in the study club with greater activity in other networks. It appeared, for example, that 75 percent of non-ERCS participants have (in 1989) a contract with a private or cooperative extension service, versus 57 percent of ERCS participants[18]. Moreover, several non-ERCS participants explicitly connect their (prolonged) relation with private extension services with lesser participation in study club activities.

> "The private extension service pleases me well, and thus I am less frequently attending study club activities."

> "My experiences with the private extension service are very satisfactory. The same man visits me every week, and those guys really visit a lot of enterprises. Also in the Westland and in Belgium. I wouldn't want to miss them; I get more out of them than from the study club. In this manner you are sure to be talking about your own cucumbers and your own climate. Also, this man really knows to get the most out of the climate computer. Moreover, he knows a lot about other crops as well. If you go to the study club every week, you hear a different story each time, and sometimes they even contradict each other. I find this more instructive than the excursion-group."

Furthermore, it was quite striking that several non-ERCS participants spontaneously pointed to the importance of contacts with other growers and traders at the auction. In contrast, none of the ERCS participants has raised this issue. While most growers hire a contractor to bring their cucumbers to the auction, several non-ERCS participants apparently bring them in themselves.

> "I find it very important to bring your stuff to the auction yourself. You have to see the products, including those of others, and talk a lot. When something is going on, you hear it at the auction."

> "Every day I visit the auction, and that is where I always meet other growers. It takes a lot of time, and that is one of the reasons that I do not participate in the small round."

It seems unlikely that -when visiting the auction- these growers have extensive discussions on the technicalities of growing cucumbers. Rather, it seems more plausible that they discuss more strategic and especially tactical issues concerning the prices, demand and supply of cucumbers and other crops. Although in terms of my earlier classification and definition of Technical Fine-Tuners and Strategic Evaluators the majority of non-ERCS participants should be labelled as Strategic Evaluators (see table 9.2), it might be more appropriate to refer to some non-ERCS participants as Tactical Market Players.

Finally, is seems that several non-ERCS participants -like ERCS participants- are part of more informal groups of two or three growers which regularly visit each others' enterprises in order to discuss more technical issues

Criteria for CT-design

First, my conclusion that the importance of a numerical ERCS should -in the context of other knowledge and information-related (study club) activities and sources- not be over-exaggerated, leads me to reinforce design-criterion 8; that is, the blessings and limitations of ERCS-participation should be realistically presented in order to avoid disappointment. Moreover, given the fact that excursion-groups function quite well in the absence of an ERCS, provisions should be made to prevent any closer link that might develop between an ERCS and excursion-groups (as suggested in design-criterion 2) from influencing these meetings in a detrimental manner. Providing adequate training for discussion leaders may in this respect be a useful suggestion (design-criterion 11). Furthermore, in order to achieve widespread participation among growers, any ERCS will have to include strict regulations with regard to the spreading of registration material outside the study club, especially since I have suggested in relation to design-criterion 2 that anonymity should -at least partially- be lifted (design-criterion 12). Similarly, to the same end, the study club will have to take measures in order to fight competitive excesses (design-criterion 13).

Tendencies towards homogenization? Of Quantity, Quality, and Intermediate Growers

Although in section 9.3 I expressed my wish to explore diversity in terms of classifications which are directly rooted in knowledge-related practices, I could not resist to also explore classifications which relate to production strategies. Building upon such a classification, the associations between different strategies and knowledge-related practices could be explored in much the same way as in chapter 8.

As I have mentioned earlier, the central parameter in cucumber growing seems to be the cumulative turnover in guilders per glasshouse square metre. At first, growers appear to agree unanimously that this parameter should be as high as possible. Even if many growers agree that growers who have relatively low fixed costs (e.g. those who use glasshouses that are already written off) may reach similar -if not better- net incomes while having lower productive results, this is quite generally seen as feasible only in the short term. In the longer term it is -for those who wish to continue in horticulture- considered to be of crucial importance to modernize the enterprise, and invest in glasshouses in which the highest possible productive results can and (due to high costs) must be obtained.

At closer investigation, however, there seem to be different views on *how* exactly a high cumulative turnover in guilders per square metre can and should be secured. From discussions with growers, it appears that many see a tension between the production of 'quality' and 'quantity'; to a certain degree the two are mutually exclusive[19]. The most important criteria for 'quality' that growers mention are tenability, shape and weight (such things as taste and health risks seem to play no role whatsoever). Growers can influence the balance between 'quantity' or 'quality' through different practices in relation to stoking (relatively high or low temperature and/or humidity), harvesting ('heavy' or 'light' cutting) and cropping system (planting two or three times a year). Thereby, it must be noted that quite generally growers argue (at least in 1989) that quality is insufficiently valued at the auction. Many growers indicate that therefore they do not grow cucumbers of optimal quality, while those who do grow quality are considered to be depriving themselves.

At this point, I will not elaborate the production-technical, economic and/or auction-technical details. Suffice it to say that growers appear able to classify themselves and others on a scale of 'quality' versus 'quantity' production. When asked about their actual way of operating, four growers explicitly indicated that they were going for quantity production. An additional six growers responded that -despite insufficient immediate reward- they continued to strive for quality production, while the remaining twelve growers took an intermediate position, and claimed that they were trying to find a balance between the two extremes. The meaningfulness of the resulting differentiation between *Quantity Growers*, *Quality Growers*, and *Intermediate Growers* is enhanced by the fact that there are indications that we are dealing with different age groups of growers (see table 9.4).

Table 9.4: Average age, average enterprise size and average year of building the eldest/ newest glasshouse section, for growers with different production strategies.

	average age (years)	average size of enterprise	average year of building of the oldest section	average year of building of the newest section
Quantity Growers (QNG) (n=4)	35	10,875 m^2	1974	1986
Quality Growers (QLG) (n=6)	47	8,633 m^2	1978	1982
Intermediate Growers (IG) (n=12)	40	12,563 m^2	1977	1984
F, p, and pairs of groups which differ at $\alpha = 0.05$	F = 3.37 p = 0.056 QLG vs QNG	F = 1.68 p = 0.21	F = 0.24 p = 0.79	F = 1.73 P = 0.20

Analysis of variance tests, comparing the means of the four 'dependent' variables for the categorization variable, were carried out. In each test, a DUNCAN procedure was used in order to identify pairs of groups that have significantly different means at the $\alpha = 0.05$ level. In relation to the 'dependent' variables presented in table 9.5, similar tests were carried out.

I am aware that in this table (and even more so in table 9.5) the numbers of cases per cell are for two categories lower than is required for such analyses. Nevertheless, I have decided to conduct such analyses for exploratory purposes, even if under these circumstances the likelihood of finding statistically significant differences is limited. In some cases, however, the sociological significance of the differences may be higher than the statistical significance.

It seems that the younger growers are, the more they are inclined towards quantity production. In the context of this study I do not have enough material to adequately interpret this phenomenon. It may be that this phenomenon reflects different economic and financial considerations that emerge from family cycle and/or succession-related circumstances. Similarly, it is not unthinkable that (perhaps at the same time) there are diverging normative convictions between age groups. A similar argument can be made with regard to the fact that the more senior Quality Growers also have the smallest enterprises, and tend to have slightly less 'modern' glasshouses.

Also in terms of actual production results (1989 figures were available in relation to only the fourteen ERCS participants) a rather clear (albeit not statistically significant) pattern emerges. When calculated per m^2 per week of cucumber production[20], the Quantity Growers have the highest results for a large number of parameters (some of which clearly have 'quantity' connotations) whereas Quality Growers seem to systematically have the lowest results (see table 9.5). Hence, it may be that the Quality Growers have the lowest intensity in terms of the number of products per space and time unit. However, in terms of the average weight per cucumber -an important quality indicator- the Quality Growers seem to be doing best; on average their cucumbers weigh 524 grams, versus 507 grams for the Immediate Growers and 505 grammes for the Quantity Growers ($F = 1.16$; $p = 0.35$).

Table 9.5: Average production results per m^2 per week for ERCS participants with different production strategies

	number of cucumbers $/m^2/week$	kilograms of cucumbers $/m^2/week$	guilders $/m^2/week$	balance $/m^2/week$
Quantity Growers (n=2)	2.89	1.45	1.85	1.49
Quality Growers (n=4)	2.38	1.25	1.55	1.14
Intermediate Growers (n=8)	2.76	1.40	1.78	1.42
F, p, and pairs of groups which differ at α 0.05	$F = 1.52$ $p = 0.26$	$F = 0.98$ $p = 0.41$	$F = 1.15$ $p = 0.35$	$F = 2.07$ $p = 0.17$

Unjustified copying and homogenization?

When looking at enterprise registration and comparison practices it emerges that 67 percent of both the Intermediate Growers and the Quality Growers are ERCS participant, versus 50 percent of the Quantity Growers. When the different options (see section 9.2) within the existing ERCS are taken into consideration, however, a greater differentiation emerges. Of the Intermediate Growers, 58 percent use the ERCS for climate registration and comparisons, and an additional 25 percent have done so in the past; for Quantity Growers both percentages are 25 percent, whereas for Quality Growers they are 33 percent and 0 percent. For the registration and comparison of crop-protection a similar -but less pronounced- pattern emerges. Of both Quantity and Quality Growers, 50 percent use the ERCS for this purpose, whereas 58 percent of Intermediate Growers do so at present, and an additional 17 percent of them have done so previously. Furthermore, it appears that a relatively large number of Quality Growers (50%) and Quantity Growers (75%) (versus 33% of Intermediate Growers) have developed alternative modes of registration outside (or on top of) the existing ERCS.

Hence, it seems that Intermediate Growers are more active if it comes to using the existing ERCS than growers with a more extreme production strategy. Moreover, and although the ratio of Technical Fine-Tuners and Strategic Evaluators -as defined earlier on- seems fairly even among growers with different production strategies (i.e. 50%/50% for Quantity and Quality Growers and 33%/67% for Intermediate Growers; see table 9.6), there are indications that the more 'extremist' growers find the excursion-groups of lesser importance than Intermediate Growers (see table 9.7).

When compared to the Intermediate Growers, both the Quantity and Quality Growers tend to relatively highly value comparing with previous years, while they -and especially the Quantity Growers- grant less priority to comparing with members of the excursion-group. In all, the impression emerges that both Quantity Growers and Quality Growers are less active if it comes to comparing with *others* than Intermediate Growers. This phenomenon can be interpreted in various ways.

Table 9.6: Number of growers with different production strategies that label a particular mode of comparison as 'most important'.

	Quantity Growers (n=4)	Quality Growers (n=6)	Intermediate Growers (n=12)
previous years	1	1	2
members of the excursion-group	2	3	4
overall averages	0	1	2
selected growers outside the excursion-group	0	1	4
norms	1	0	0

Table 9.7: Average importance of each comparison opportunity on a four point scale (1 = 'not important', 2 = 'moderate importance', 3 = 'important', 4 = 'very important'), for growers with different production strategies (average rank-orderings between brackets).

	Quantity Growers (n=4)	Quality Growers (n=6)	Intermediate Growers (n=12)
previous years	(1) 3.3	(1) 3.2	(2) 3.0
members of the excursion-group	(3) 2.5	(2) 2.5	(1) 3.3
overall averages	(2) 2.8	(3) 2.3	(3) 2.8
selected growers outside the excursion-group	(4) 2.3	(4) 2.2	(4) 2.3
norms	(5) 1.5	(5) 1.8	(5) 1.8

Since there seems to be an association between production strategy and age, it might be assumed that different age groups have different attitudes towards mutual cooperation and comparison. It could, for example, be argued that the Quality Growers were brought up in a time that (the need for) mutual exchange and comparison in study clubs had not fully developed yet, whereas Intermediate Growers are spoon-fed with comparison activities. Quantity Growers, then, have presumably been reared in a time of increasing individualization and competition, so that they are less inclined to sharing knowledge with others. Although I have no direct evidence which supports such an explanation, it partly coincides with recent worries expressed by NTS personnel (personal comment, 1993) concerning the willingness of growers to continue mutual exchange of knowledge (see the next section).

Alternatively it could be argued that (partly in connection with age related factors) growers with more 'extreme' production strategies are less inclined to compare with others and/or that those who are inclined to compare with others somehow loose their 'extremist' ideas, and become tempted to take an intermediate position. Below, I will present some qualitative evidence for this latter combination of explanations.

In section 9.1, I have pointed to both the vulnerability of horticultural activity and the ever continuing stream of new technologies and innovative ideas that are introduced in the sector. Thus, it is not surprising that growers can be rather uncertain about which interventions and/or investments to make. Although some growers have -at least temporarily- very particular ideas on what needs to be done, a large number of growers is at times confused and therefore quite happy to rely on the judgements of others. In this context, one might assume that those who are most heavily involved in comparison activities are those who are relatively uncertain, and therefore inclined to 'play safe' and/or 'strike the golden mean'. This, then, sometimes leads to the following phenomenon:

> "When we started with the climate computer we formed a little group of people with the same computer with the aim of comparing our settings and results. We stopped after four meetings because we came so close to each other that there remained nothing to talk about."

> "At the moment we are a rather homogeneous group, but that was not the case when we started."

Clearly, it is a central aim of the study club that growers learn from each other, and thus it is perhaps unavoidable that -in certain respects- growers start to resemble each other. However, several growers and extension workers have worries about an increasing tendency towards homogenization which -in their view- rests on the unjustified copying of certain practices. That is, growers take over practices from others on the basis of a wish to minimize deviation from others, rather than on the basis of thorough analysis. A commercial extension worker argues:

> "The consequence of all that rapid exchange of data is that growers start converging towards each other, whereas in fact they all have different glasshouses, computers, etc. They are increasingly taking over what their neighbour is doing, and it really takes a lot of energy to talk them out of that."

A grower confirms:

> "The small group has in the past year really grown towards each other. Fortunately, they are going to mix the whole thing again. People shouldn't become too much alike. Growers who are very sensitive start to do what others do, but I am of the opinion that you cannot orient yourself towards that. It is very dangerous to copy what someone else is doing. You have to try and analyze, and if you cannot come to a clear conclusion, you mustn't pay too much attention. There may be all sorts of structural matters of which you do not think so easily. You have to do your own thing."

Surely, different levels of uncertainty, self-opinionatedness and/or different ways of dealing with risk cannot fully explain the different ways in which Quantity Growers, Quality Growers and Intermediate Growers seem to deal with registration and comparison. However, this classification in terms of production strategies -even if it does not directly originate from diversity in knowledge-related practices- has helped to uncover a specific (and quite plausible) phenomenon, namely that of possibly unjustified copying and homogenization.

This phenomenon links up with my earlier discussion with respect to the difficulties of drawing adequate conclusions. Therefore, the criterion can be formulated that any ERCS - especially when it has high speed of data exchange- should include some training of participants in the drawing of conclusions (design-criterion 14). Moreover, if an ERCS would be linked explicitly with the excursion-groups (as suggested in design-criterion 2), my discussion in this section confronts us with even more questions about how such excursion-groups are and should be composed. I will deal with that issue in the next section.

Excursion-groups and their composition: negotiating definitions of homo and heterogeneity

The great majority of excursion-groups meet -at least during crucial periods in the growing season- once a week, usually on friday afternoon. The exact mode of working varies with the excursion-group. Usually a meeting consists of two collective activities (the sequence of which varies): a round through a glasshouse, and a plenary discussion in the canteen. In most cases, the weekly figures of the enterprise at which the meeting takes place are announced and written down by all growers on a special form. The number of enterprises that are (or can be) visited varies (minimum one and maximum three), and so does the size of the group (minimum six and maximum twelve) and -in relation to this- the frequency in which separate enterprises are visited.

In one of the excursion-groups each enterprise is visited every second week; the other extreme is that in another group individual enterprises are visited only once in ten weeks. In again another group, the growers have decided to visit the same two enterprises the whole year round. Usually, the enterprises are visited according to a regular schedule, which can, however, be deviated from when necessary (e.g. when interesting things occur at a particular enterprise). Each group has a group leader, who has the formal responsibility to structure the meetings and chair the discussion. The subjects that are discussed vary considerably, according to the season, the market, the trends, the news, the weather, etc. (see for a detailed report of such a meeting appendix 2).

Excursion-group composition is decided upon yearly by members of the Study Club Board, and is officially guided by the principle that the excursion-groups are meant to learn from each other. Therefore the Board considers it unacceptable to put 'the best' growers all in one group. Most growers seem to accept this rule:

> "My group is rather heterogeneous, and for me that is a negative characteristic. I have pretty high productive results, which means that I am interesting enough for others. For my own good I would like to change, but I wouldn't like to turn down others either. You can't do that in a study club."

> "In theory, of course, you can improve more when you are all the same. Especially people with the same mentality; people who wish to progress. For the sake of the study club you can't do that, but I myself would benefit more if it could be done like that."

In the interviews, I have asked growers whether they considered their excursion-group to be either composed homogeneously or heterogeneously (in terms of technical criteria such as cropping system, type of glasshouse, etc.), and whether they considered this to be a positive or a negative characteristic. Despite the acceptance of the 'heterogeneity principle' as a mere inevitability, a majority of 64 percent indicate (like above quoted growers) that they -for their own purposes- would appreciate a (more) homogeneous excursion-group. Of these fourteen growers, seven argue that they are in an excursion-group that is 'too heterogeneous' (heterogeneous/negative), while the other half is satisfied with their group which they characterize as 'homogeneous' (homogeneous/positive).

Although I have -in the questions put forward to growers- described homo and heterogeneity in very concrete terms, it was quite interesting to see that growers referred to different types of criteria for evaluating 'homogeneity' and/or 'heterogeneity' when discussing the ideal composition of excursion-groups. Some growers -like the last quoted one- speak of criteria such as 'mentality' and 'progressiveness':

> "The most important criterion for me is the quality of the grower; type of glasshouse and planting date, etc., are not so important to me. The grower is the determining factor, and you have to adjust to the rest."

> "The group is too varied, but in our location it is hard to get it changed. There are people here who hardly ever leave their garden and are terribly conservative."

Others, however, apply much more concrete criteria:

> "I don't care who is in the group, as long as they are top producers."

> "I would prefer to have growers with the same glasshouse and the same heating system. That way it would be much easier to compare."

> "With those large differences in planting dates, my interest fades away pretty quickly."

> "I'd rather travel longer distances, and have similar planting dates."

The remaining eight (36%) growers seem to appreciate a fair level of heterogeneity; they argue that they are quite happy to be in a group which is 'heterogeneous' (heterogeneous/positive).

> "Of course they all have the same substrate, tubes and a climate computer, but still there are a lot of differences in age, mentality, types of glasshouses, etc. It is a very varied group. I am really happy with that; life can be boring enough as it is. You need a different opinion once in a while."

> "I always say: "Make a big mess of it, a nice hotchpotch." For me they can put differently aged growers, or growers with old and new glasshouses all into one group. There are many who do not agree with me. Of course, it is true that solutions that, for example, small growers have, do not apply for my type of enterprise. But still, they make you think. It is good to calculate for others; you easily resort to talking yourself clear."

Another 'heterogeneity-minded' grower points to two issues that are interesting for further discussion.

> "From a crop-technical point of view you would like them to be all the same. But someone with a lower glasshouse, who is still doing well ..[thinks].. no, at second thought I think that variation

is a good thing. You can learn a lot from it. Anyway, you never get an homogeneous group for long; the developments are much too fast."

Re-homogenization, and the difficulty of arriving at an acceptable excursion-group composition

As the last cited grower argues (even if he corrects himself), it seems plausible that those who are interested in crop-technical issues might be more inclined to compare with growers who grow under similar conditions. In contrast, it could, for those who are especially interested in strategic and tactical issues, be an advantage to compare with those who grow in different circumstances. Indeed it appears that a relatively large proportion of Technical Fine Tuners seem to be in favour of homogeneity, for 78 percent of these growers (versus 54% of Strategic Evaluators) give answers to earlier mentioned questions that can be summarized as homogeneous/positive or heterogeneous/negative. Given the rather concrete definition of homo and heterogeneity suggested in the questions posed, this supports my hypothesis. Moreover, I have the impression that especially Technical Fine-Tuners -when freely discussing ideal group composition- define homogeneity and heterogeneity in very technical terms (e.g. along planting dates, types of glasshouse, etc.) whereas Strategic Evaluators pay more attention to less tangible criteria such as 'mentality' and 'progressiveness'. (In terms of the other classifications of growers which I have made in this chapter, different preferences with respect to group composition seem less pronounced and interpretable[21].)

The second point of interest in the last quote is the suggestion that homogeneity withers away quickly. At first, this seems to contradict the tendencies towards homogenization which I have discussed in the previous section, but on closer investigation it does not. The grower's remark has to be placed in the right context, which is that -in 1989- the Study Club Board had decided to compose part of the groups according to the number of times that they *intended* to plant new crops (two or three times). At that time, having three plantings a year was an innovation, and relatively few growers indicated in the beginning of the season that they would plant three times. However, quite a few growers who were planning to plant two times decided during the season that they would try three times instead. Hence, what may look like increasing heterogeneity from the point of view of a particular excursion-group, can still reflect a tendency towards homogenization for the study club as a whole. More precisely, one would have to speak of rather quick *re-homogenization*. That is, in the technological rat race which characterizes horticulture, one frequently sees that particular innovations become rapidly adopted as soon as a small number of growers have tried them out. This happened for example with the climate computer, biological crop-protection and - as I will show in chapter 10- also with a particular automated ERCS.

In all, it becomes clear that determining the composition of excursion-groups is a rather complex task. First of all, the Study Club Board has to choose between an extremely large number of criteria which can be used to determine the 'homogeneity' or 'heterogeneity' of excursion-groups (see box 9.5).

In practice, I noticed that the criteria the Study Club Board uses for making a group composition varies through time and with the excursion-group. These criteria, then, are not so much 'rationally chosen' by the Study Club Board, but rather they seem to be the outcome of a complex negotiation process. This brings me to the second complicating element, namely that decisions concerning group composition are inherently political in nature.

Box 9.5: **Criteria which different interviewed growers have proposed as being relevant for group composition.**

- type of glasshouse (height, type of glass, width of windows);
- planting dates;
- cucumber cultivars;
- level of participation in the existing ERCS;
- climate computer;
- heating system;
- size of enterprise;
- age of grower;
- thematic interest;
- preferred mode of working in excursion-groups;
- level of education;
- type of personnel (fixed or variable);
- cropping system (2 or 3 plantings, second crop);
- level of production per m^2;
- geographical location;
- production strategy;
- personal preferences;
- mentality;
- progressiveness;
- quality;

Since there are all sorts of personal preferences and interests involved, group composition appears to be a 'hot' issue. At a particular point in time, every grower has a particular idea about the ideal composition of their own excursion-group, whereby one or more of above mentioned criteria play a role. Not surprisingly (given earlier discussed competitive issues), I gained the impression that growers with the highest productive results per m^2 are particularly 'wanted', and so are growers who have recently invested in new technological innovations. These highly 'wanted' growers themselves, in turn, have their own interests as well; i.e. they do not want to be in a group with only 'weaker' growers. In fact, it may be that especially highly productive growers stress the importance of having 'homogeneous' excursion-groups[22].

There are indications that growers exert considerable pressures on the Study Club Board to influence group composition. Because of their status and the fact that others have to depend on their cooperation, growers that are 'wanted' at a given point in time are in a particularly good position to exert influence. Some evidence that they are indeed successful in this respect, arises from the fact that those who positively evaluate their excursion-group as 'homogeneous' (homogeneous/positive, $n=4$) are growers with extremely high productive results (on average fl. 1.90 worth of cucumbers yielded per m^2 per week, versus on average fl. 1.66 for the rest; $T = -1.41$; $p = 0.18$).

In an effort to ensure a favourable group composition, growers can (and do) formally or informally propose certain criteria to the members of the Study Club Board. Also, small groups of growers can coordinate certain practices, so that they are almost automatically grouped together. It seems, for example, hardly coincidental that the excursion-group with the highest intensity of comparison (they visit three enterprises a week) consists of six growers who live in one particular enclave, and who are the only ones in the whole study club who grow tomatoes in the second half of the year. Moreover, some growers are in a position to threaten the study club that they will start a small group of their own and discontinue their participation in the study club's excursion-groups.

At the national level, the NTS is increasingly worried about the decreasing willingness of some growers to share knowledge and experience. It is thought that especially growers who are involved in systematic attempts to generate new knowledge (either alone or in cooperation with other growers and/or public or private research institutes) find participation in study clubs increasingly problematic[23]. At least until 1990, however, the southern study club had managed to keep its highly productive members (and/or others that are 'wanted' for different reasons) on board. In my view, this is not so much because growers endorse the normative and ideological principles of the study club (from which it follows that it is unacceptable to put 'the best' growers together in one group). Instead it seems crucial that: (a) the Study Club Board was able to compromise with particular growers, and (b) that despite the fact that growers may have short term interests to operate outside the study club, the most 'wanted' growers too have several long-term interests to continue their participation.

Already in my introduction to the phenomenon of study clubs (section 9.1) I have mentioned that -in several ways- maintaining good relationships with other growers is a matter of insurance and reduction of risk. Moreover, no grower can be sure that he or she will always be the most productive, and/or the first to apply new practices and technological innovations. Thus, they need -in order to ensure access when needed- to remain at least on speaking terms with other members of the study club. This is reinforced by the fact that, if growers formed their own groups outside the study club, they would probably have to stick to each other for a relatively prolonged period of time; i.e. the opportunities to change group composition become limited. Given the homogenizing tendencies discussed earlier on, and the fact that growers become 'bored' with each other after a while, this is not a terribly attractive option.

> "They have taken a few good ones away from our group, and that is a pity. On the other hand, it was good to tear the whole thing apart, since we had been together for far too long already. Furthermore, I find that the group leaders need to be instructed better, since the discussions sometimes get out of hand."

> "It isn't right to continuously go around in the same circles; you get tired of looking at each other."

In the context of this study, I was not able to comprehend all of the processes and negotiations that influence the eventual composition of excursion-groups. There is no doubt that many things remained invisible. Nevertheless, it is plausible that the process of arriving at a composition of excursion-groups is associated with a somewhat hidden struggle in which different definitions of homo and heterogeneity are negotiated. Despite the fact that in this process the formal ideology of the study club can be violated, the fact that there is space for manipulations seems to be of vital importance for the effective functioning of excursion-groups in the long term. Of course, the Study Club Board can never totally satisfy all growers, but the idea that group compositions can be influenced, and will be changed again within a reasonable period, does maintain growers willingness to participate. Therefore, an important criterion for any ERCS that is to be linked explicitly with excursion-groups (design-criterion 2), is that organizational arrangements are made so that growers can effectively influence group composition (design-criterion 15).

9.5 The prospects of the postal ERCS

In the previous section, I have identified fifteen design-criteria which any ERCS ought to meet in order to adequately support the registration and comparison activities of a large majority of southern stoke-cucumber growers (see box 9.6 for a summary).

Box 9.6: **Essence of design-criteria identified in section 9.4.**
On the basis of qualitative impressions and personal judgement I have marked those design-criteria that seem of vital importance with '*'.

criterion 1: * Parameters need to anticipate diversity.
criterion 2: * An ERCS needs to be linked with excursion-groups.
criterion 3: Additional context information needs to be provided.
criterion 4: Small groups need free comparison space.
criterion 5: * Arrangements that allow for flexibility need to be present.
criterion 6: Opportunities for assessing validity and reliability need to be provided.
criterion 7: Procedures for correcting faulty parameters need to be present.
criterion 8: An ERCS needs to be presented realistically.
criterion 9: * Gradual learning processes need to be accommodated.
criterion 10: Sanctions on discipline violation need to be included.
criterion 11: Training for discussion leaders needs to be provided.
criterion 12: Spreading of registration material outside the study club needs to be prevented.
criterion 13: Arrangements need to be provided that lower competitive excesses.
criterion 14: Training of participants needs to be provided.
criterion 15:* Growers need to be able to regularly influence group composition.

For some of these design-criteria it is, in relation to the existing postal ERCS, immediately clear that they are of a primarily '(software-)technical' nature. That is, they can be met by means of an adequate internal design of the central database and the print-outs (for example criteria 1 and 4). Other design-criteria are of a more 'organizational' nature, since they can only be met by realizing certain organizational arrangements (for example criteria 8, 11, 13, 14 and 15). The majority of design-criteria, however, seem to have both a 'technical' and an 'organizational' dimension, for these requirements can either be met by means of adequate provisions in the internal *or* external design (see section 7.3), and in many cases a combination would seem quite sensible (for example criteria 2, 3, 5, 6, 7, 9, 10 and 12).

A detailed discussion of the extent to which the existing ERCS meets the design-criteria (and/or can be modified to do so) is presented in appendix 3. In the main text, I will suffice with the conclusion that follows from this discussion, and then continue to discuss in more detail the prospects of two 'automated' ERCS in this respect.

The conclusion that can be derived from appendix 3 is that there are numerous ways in which the existing postal ERCS can be realistically improved, and thus that it has a reasonable potential. In terms of the design-criteria, the only major drawback seems to be that in a postal system, it is difficult to give growers the opportunity to extensively 'play around' with database material. Given the fact that many of the proposed improvements have an 'organizational' dimension, another bottleneck may be the organizational capacity of the study club. Although the study club has many members who are active in various ways, the organizational work remains in the hands of a few volunteers, while the central processing of the registration material depends on one particular private person. Hence, continuity in the making, monitoring and implementation of improvements to the postal ERCS cannot be easily guaranteed. Furthermore, important decision on changing the ERCS (e.g. altering anonymity regulations, and making connections with the excursion-groups) depend on the support of the study club members at the general assembly. On the one hand, this is a strength of the existing ERCS, since this means that major decisions on changing the ERCS can be taken relatively quickly and democratically. On the other hand, the fact that decisions with major consequences can be taken rapidly, also implies a danger that decisions follow the issue of the day and lack screening on their long term implications.

9.6 The prospects of INFOTUIN/TVPC and TELETUIN

As was mentioned in section 9.1, the southern study club was confronted with two communication technologies (INFOTUIN/TVPC and TELETUIN) which were aimed at supporting registration and comparison activities. Given the dissatisfaction with the existing postal ERCS, the Registration Committee had been tempted to adopt one of the two. However, they were not sure which one to choose. Hence, they were quite happy to postpone the decision, and wait for the results of this study.

In this section, I will discuss and compare the prospects of the two competing 'automated' ERCS (in their 1990 versions) against the background of both the design-criteria that were developed in section 9.4 and the existing postal ERCS.

Introduction to INFOTUIN/TVPC and TELETUIN

INFOTUIN/TVPC and TELETUIN are 'automated' ERCS which resemble each other in a number of respects. In both cases, growers electronically (i.e. with the help of a modem and telephone lines) supply their weekly registered parameters to a central computer. In the same manner, growers can retrieve their own and other growers registration material. When all growers effectively send in their respective parameter values at an agreed point in time, the exchange of these can take place very rapidly. In fact, the perceived benefits of such speedy exchange has -at least initially- been the most important argument for developing such CT. Another resemblance between the two CT is that both include a 'processing module'. With the help of this module, growers can easily make selections from the database and/or produce graphical representations in relation to (part of) the parameters that are included. In this section, I will show that the two CT are -despite these basic similarities- characterized by a number of substantive, technical, historical, organizational and regional differences.

INFOTUIN/TVPC

Although -in most instances- I will speak of INFOTUIN/TVPC as one package, it is in fact composed of two separate CT. With the help of INFOTUIN ('tuin' means garden), growers can supply, store and retrieve registration parameters from a central database. In order to access INFOTUIN (which is based on videotex technology), growers have to use a telephone line. When linking up with the central INFOTUIN computer in this manner, growers have access to overviews of registration material which are essentially similar to those provided in the postal ERCS (i.e. matrices of rows and columns which represent particular growers and/or parameters). INFOTUIN itself is in fact a composite package as well; apart from supporting registration and comparison activities, a significant feature of INFOTUIN is that it is also used for sending on the daily accounts from the auction to the growers[24].

Regional study clubs, the NTS, the SITU (the horticultural branch organization, see section 7.1) and the auctions (all primarily located in the Westland region) have actively participated in developing INFOTUIN, while the Ministry of Agriculture has granted financial support under the auspices of INSP-LV (see section 7.1).

In 1989, SITU and NTS initiated the development of TVPC (an acronym for Crop Comparison on Personal Computer) as an addition to and improvement of INFOTUIN. TVPC is a 'processing module' which allows growers to make graphical representations in relation to several parameters. Furthermore, it provides growers with the opportunity to access part of the registration material in an off-line fashion. That is, with the help of TVPC, growers need to be on-line only for sending and retrieving *files* with updated registration material, while they can quietly enter and/or look at these parameters on their own local computer, without having a continuous connection with the central computer. With the development of TVPC, SITU and NTS hoped to overcome two bottlenecks which had become apparent in relation to INFOTUIN, namely that: (a) the telephone costs related to the use of INFOTUIN appeared rather high (due to the fact that growers could only access the database in an on-line fashion), and (b) that INFOTUIN did not provide facilities for making graphical representations (whereas the competing package did).

In essence, INFOTUIN and TVPC were designed by using a 'project oriented' method of CT-development (see section 7.4). Thereby the 'functional design' was made by growers, SITU and NTS, while particularly the making of a 'technical design' and the actual building of these CT was left to externally hired professionals. Historically, INFOTUIN was first developed for Westland tomato growers. At a later stage it was extended to other fruit-vegetable crops and regions. TVPC was designed from the outset in order to cater for a wide range of growers. (In chapter 10, I will deal much more extensively with the development histories of INFOTUIN, TVPC and TELETUIN.)

TELETUIN

In TELETUIN a 'processing module' has already been incorporated in the package at a relatively early stage, which means that all TELETUIN participants have the opportunity to make graphical representations in relation to a variety of parameters (whereas subscribers to INFOTUIN need to buy TVPC as well). The TELETUIN software (like TVPC but unlike INFOTUIN) runs on the local computer of the grower; the central computer is only accessed briefly each week for sending and/or retrieving up-to-date registration material.

TELETUIN was developed through a very informal 'prototyping' process (see section 7.4), in which several growers, an extension worker and a small agro-software firm (DACOM) were involved. The development of TELETUIN was a typical 'low-budget' effort, that took place without external subsidies, and in which a lot of unpaid spare time was invested. While the development of INFOTUIN/TVPC was primarily a Westland region affair, TELETUIN was -at least until 1989- an exclusively northern undertaking. Both participants and developers work and/or live close to the horticultural enclaves of Klazienaveen and Erica in the northern province of Drenthe. Originally, TELETUIN had been developed only for cucumber growers, but from 1989 onwards, versions for several other crops have been introduced as well.

Design-criteria, the postal ERCS and the added value of INFOTUIN/TVPC and TELETUIN

Below, I will discuss the prospects of INFOTUIN/TVPC and TELETUIN in relation to those five design-criteria that I have labelled as being of vital importance (see box 9.6). Discussions in relation to the other criteria, as well as considerations regarding costs and continuity, can be found in appendix 4. When dealing with design-criterion 9, I will introduce some additional empirical material on different modes in which growers use the graphical facilities provided by INFOTUIN/TVPC and TELETUIN. Although my elaborations are based on the 1990 versions and arrangements, I will -for editorial reasons- continue to use the present tense.

Criterion 1: anticipating diversity
When discussing the extent to which INFOTUIN/TVPC meets growers diverging interests in terms of the parameters included, it is necessary to separate between INFOTUIN and TVPC.

The opportunities to register and compare production figures in INFOTUIN are less extensive than in the postal ERCS (see section 9.2 and table 9.8); some specifications in relation to the number of cucumbers yielded per m^2 are missing, and so are most of the cumulative parameters. The climate registration is much more concise as well; the postal ERCS includes 67 weekly parameters in relation to climate versus 11 in INFOTUIN. Only in relation to the registration of feeding (water and fertilization) are the two packages roughly equivalent.

Furthermore, INFOTUIN does not explicitly include crop-protection parameters (even if individual excursion-groups can use so-called 'free pages' for including them). However, INFOTUIN includes a labour registration section, which is totally lacking in the postal ERCS. As is the case in relation to the postal ERCS, growers can participate in INFOTUIN at various levels, whereby -in contrast to the postal ERCS- the minimum package includes the climate registration.

In principle, INFOTUIN also provides the opportunity to exchange parameters on a daily basis. The idea to make daily comparisons originates from the observation that outside climatological conditions fluctuate heavily, so that climatological interventions within the glasshouse necessarily vary as well. However, only fourteen percent of the interviewed growers in Brabant/Limburg indicate that they have an interest in making daily comparisons, and none of the five INFOTUIN users who were interviewed made use of these facilities. Most growers indicate that the making of daily comparisons would be too time consuming. Only under extreme conditions the need does sometimes arise to know what someone else is doing on a particular day, but -according to most growers- this does not justify a daily comparison routine. Growers indicate that -in such cases- they simply visit or ring someone.

Besides, one can wonder -given the concise character of the INFOTUIN climate registration, and the importance of additional context information in relation to such parameters (see section 9.4)- whether daily numerical comparisons make sense if they are not complemented with daily discussion meetings as well.

In sum, it can be argued that (apart from the labour registration) INFOTUIN includes only the most basic parameters for enterprise comparison. With respect to more specific interests, growers have to depend heavily on the 'free (videotex) pages' which are included. Disadvantages of such pages are that: (a) they are rather laborious to complete; (b) no cumulatives or averages can be automatically calculated in relation to the parameters included in them; and (c) (unless very good agreements are made) they have relevance only within one excursion-group. Of course, these bottlenecks would hold for the postal ERCS as well if free columns were included in it; however, the postal ERCS includes already so many parameters that the use of such free columns can be restricted for very specific occasions and interests.

Apart from facilitating off-line working with a selection of parameters included in INFOTUIN, TVPC offers the opportunity to make graphical representations of 11 parameters relating to climate (8), energy use (1), fertilization (2) and production (1). Although at the time of interviewing none of the TVPC users had extensive experience with the package (it had just been introduced), it was already clear that the choice of parameters in this respect was unfortunate. The one production parameter included is the number of cucumbers yielded per m^2 per week, whereas Strategic Evaluators (see section 9.4) naturally have a clear preference for making graphs concerning (several!) *cumulative* production figures over a longer period of time. Moreover, they are thereby only occasionally interested in the relation between such cumulative production figures and climatological parameters.

Similarly, for those with a more permanent interest in climatological issues (e.g. Technical Fine-Tuners) the parameters chosen are far from ideal. Apart from the fact that such growers do not find parameters which express climatological *weekly averages* very insightful anyway (see section 9.4), they too like to graphically evaluate their climate versus several (indeed weekly) production parameters. Such parameters, then, should not only relate to the overall quantity of production, but also specify quality distributions, average weight per cucumber, etc. Finally, the suppliers of climate computers increasingly offer facilities for making climatological graphs as well, so that for some growers the provision of such graphs by TVPC is rather superfluous.

In all, the graphical facilities offered in TVPC are -in terms of the parameters included in it- far from optimal. Similarly, although it is certainly an advantage of TVPC that parameters can be accessed off-line, there still remain a lot of parameters (the free pages, the labour registration and most of the production parameters) which can only be accessed in an on-line fashion.

In TELETUIN, less production parameters are included than in the postal ERCS as well, and those that are incorporated are roughly similar to those provided in INFOTUIN/TVPC. This equivalence holds also for the number and types of parameters on fertilization and water use. In terms of the number of weekly parameters on climate that are incorporated, TELETUIN has an intermediate position; TELETUIN includes 24 weekly parameters in this respect, versus 11 in INFOTUIN/TVPC and 67 in the postal ERCS. Crop-protection registration is explicitly included in TELETUIN (although -like in INFOTUIN- it is located in the 'free space'), while TELETUIN includes neither a labour registration nor facilities for making daily comparisons. Like INFOTUIN and the postal ERCS, TELETUIN offers the opportunity to participate at different levels in that it is organized in different 'blocks' of parameters, which growers can choose to send in or not.

The parameters that can be represented graphically relate to both climate and fertilization (10) and weekly, cumulative and total cumulative production (altogether 14). The inclusion of several cumulative production graphs is clearly highly beneficial for those who are particularly interested in strategic and tactical issues, while the greater variety of weekly production graphs meet some of the interests of those with a primarily crop-technical interest. Apart from the 24 lines per enterprise, TELETUIN can produce an additional twelve 'difference' lines whereby the value of parameters from one enterprise is subtracted from those of another. Moreover, TELETUIN includes fourteen parameters for which the overall averages can be represented graphically through time. Finally, weekly values of a selection of participants (including the average value) can be graphed in relation to thirteen parameters.

Table 9.8: Number and type of parameters included in different ERCS (1989 versions).

	Postal ERCS	INFOTUIN/TVPC	TELETUIN
PRODUCTION			
per week	15	11	7
cumulative per planting	14	8	6
total cumulative	14	0	0
averages	42	15	13
TOTAL	*85*	*34*	*26*
CLIMATE			
per week	67	11	24
cumulative per planting	3	1	0
total cumulative	3	0	0
averages	73	12	8
TOTAL	*146*	*24*	*32*
FERTILIZATION/WATER			
per week	5	7	8
cumulative per planting	1	2	2
total cumulative	1	0	0
averages	3	7	10
TOTAL	*9*	*16*	*20*
CROP-PROTECTION	*7*	*free*	*free*

It can be concluded that both INFOTUIN/TVPC and TELETUIN encompass considerably fewer parameters than the postal ERCS. Even if the number of especially climatological parameters in the latter may be excessive, a certain amount of redundancy (from the individual's point of view) is -in the context of diverging interests among growers- a positive characteristic, as long as: (a) it does not take too much effort to collect the parameters, and (b) growers know what they mean[25]. Hence, it emerges, from the point of view of anticipating diversity, that there is no reason to replace the postal ERCS by one of the two 'automated' ERCS. In terms of the number and types of parameters which can be graphically represented, it seems that TELETUIN can cater for the needs of a much greater variety of growers than INFOTUIN/TVPC (I will come back to other aspects of the 'processing module' later on).

Criteria 2 and 4: the link with the excursion-groups
In contrast to the postal ERCS, both INFOTUIN/TVPC and TELETUIN are explicitly designed around the functioning of the excursion-groups. Nevertheless, there are some organizational and technical differences between the two CT with respect to the ways in which they resolve the five bottlenecks which were -in relation to its connection with the excursion-groups- identified in relation to the postal ERCS (see section 9.4).

First, both INFOTUIN/TVPC and TELETUIN do not work anonymously; at the beginning of each season, growers are provided with a list of participants and their corresponding enterprise numbers. Thereby, it must be noted that in TELETUIN growers have access to the registration material and names of all (cucumber) growers within the region, whereas in INFOTUIN/TVPC, access is limited to the members of the own excursion-group; access to registration material of other groups can only be obtained on the basis of a written agreement between the two groups. Thus, while TELETUIN offers greater opportunities for comparison, INFOTUIN/TVPC has more to offer in terms of privacy protection. In this respect, TELETUIN is more similar to the postal ERCS (which also provides the registration material of all regional participants) than INFOTUIN/TVPC; even more so since 1990, when anonymity was also formally abolished in the postal ERCS.

Second, both in INFOTUIN/TVPC and TELETUIN it is possible to get excursion-group overviews of the registration material for each week; in the postal ERCS this is not yet possible (even if it could be quite easily realized, see appendix 3). Whereas in INFOTUIN/TVPC growers can (when agreed upon) get overviews of several excursion-groups, TELETUIN offers the opportunity to select any group of six growers that one would like to put in an overview. Both in INFOTUIN/TVPC and in TELETUIN it is also possible to get an overview over several weeks of one's own or another grower's enterprise. In addition, TELETUIN provides the opportunity to get overviews of two, and/or all enterprises. Hence, the facilities for numerical presentation are considerably more advanced in both TELETUIN and INFOTUIN/TVPC than in the postal ERCS. The opportunities offered by TELETUIN are more extensive than those offered by INFOTUIN/TVPC; especially the opportunity to freely select a very specific group of enterprises seems a relevant support for taking specific decisions. In this manner, growers can -to a certain extent- escape from the rigidity of a group composition which is negotiated and decided upon at a particular point in time.

Third, it has already emerged that all three ERCS offer opportunities to let growers (and thus excursion-groups) participate at different levels of registration. In principle, therefore, preferred levels of registration can be taken into account when deciding upon group composition in all cases. However, in case of the use of INFOTUIN/TVPC or TELETUIN, it is clear that the possession of a PC becomes an important criterion for group composition. Depending on how speedily growers are prepared to invest in the appropriate hardware and software, this may considerably hamper the space of manoeuvre for composing groups for a more or less prolonged period of time. As I have argued in section 9.4, however, the speed of adoption of new technologies can take place very rapidly in horticulture; when access to other growers' registration material is at stake this may indeed hold for 'automated' ERCS as well. (Both in this chapter and in the next I will come back to this issue.)

Fourth, both INFOTUIN/TVPC and TELETUIN provide free registration space, so that excursion-groups have indeed an opportunity to register and exchange parameters that only they are interested in. The postal ERCS does not provide this opportunity, although I have suggested in appendix 3 that this facility can be rather easily added.

Finally, through using INFOTUIN/TVPC and TELETUIN growers can -in principle- exchange registration material much quicker than with the postal ERCS. Although this is certainly an advantage over the postal ERCS, I have argued in section 9.4. and appendix 3 that the significance of this benefit should not be overestimated. This advantage alone is not sufficient justification for adopting an 'automated' ERCS.

It can be concluded that, although the two 'automated' ERCS (and -due to its presentation facilities- especially TELETUIN) potentially establish a more effective link with the excursion-groups than the postal ERCS, they have only a slight (and not a *fundamental*) advantage over the postal ERCS in this respect, since there is considerable scope for improving the latter.

Criterion 5: arrangements for securing flexibility through time

The possibilities to quickly adapt INFOTUIN/TVPC to new issues are limited. TVPC especially is not designed to cater solely for the needs of cucumber growers, but also for those of tomato growers, pepper growers and growers of other fruit-vegetable crops. Therefore, growers who propose certain changes, will have to reach agreement with a variety of crop committees, steering groups, national committees and administrative bodies within the complex organizational structure of the NTS. Given the different parameters that growers with different crops are interested in, such agreements would not be easily arrived at.

In fact, the dominance of climatological parameters in TVPC reflects a compromise between the needs of various groups of growers. Since relevant production parameters vary heavily from crop to crop, and whilst growers (irrespective of their crop) have 'a climate' (which could be measured supposedly in similar terms), it was considered most feasible to grant climatological parameters a prominent position (see chapter 10).

On top of these difficulties, the distributors of INFOTUIN/TVPC (SITU/NTS) are not in the position to change the packages themselves; for practical and historical reasons (see chapter 10) they need to instruct commercial software firms to do so. Hence, the making of changes in both INFOTUIN and TVPC will be very expensive[26].

In contrast, the possibilities to adapt TELETUIN are considerable (and have at times even been too large, see chapter 10). This flexibility is connected with a variety of circumstances. First, both distribution, design and implementation are essentially in the hands of one person, who is indeed willing and able to work quickly and cheaply in response to growers' feedback. Second, the fact that TELETUIN is designed from the philosophy that growers of different crops needed their own particular ERCS, means that no compromises have to be found between growers with different crops. Third, because of the highly local and informal nature of arrangements around TELETUIN, decisions on changing TELETUIN can be taken rapidly.

It can be concluded that -as at 1990- the flexibility of TELETUIN is much greater than that of INFOTUIN/TVPC. Of course, if DACOM were to grow into a larger organization, and if the number of TELETUIN users would increase, this flexibility might be somewhat reduced. Similarly, SITU/NTS may be able to obtain funding for making fundamental changes to INFOTUIN/TVPC, which will also guarantee greater flexibility in the future. Nevertheless, it seems that the flexibility of the postal ERCS is (and will be) superior over that of the two 'automated' ERCS, since the southern study club has total autonomy in this respect (see section 9.4). Not only the organizational aspects are important in relation to this, but also the fact that -in order to change the postal ERCS- only the central database needs to be altered rather than all the local 'processing' and/or communication hardware and software.

Criterion 9: accommodation of gradual learning processes
The most tangible added value offered by the 'automated' ERCS is the opportunity to 'process' registration material (albeit to a limited extent). In both cases, the facilities for 'playing around' consist mainly of easy retrieval and graph-making opportunities. In addition, I have argued earlier in this section that TELETUIN provides growers with extensive facilities for making group overviews. Neither TELETUIN nor INFOTUIN/TVPC allows growers to make calculations with the registration material. In both cases (and most explicitly in the case of INFOTUIN/TVPC), however, it is possible to make an ASCII file of the database, which can be retrieved in (for example) a spreadsheet program, so that calculations can be made outside the ERCS. (In principle this possibility exists in the postal ERCS as well, see appendix 3.) Despite the broad similarities between INFOTUIN/TVPC and TELETUIN in this respect, the way in which graphical facilities are designed in more concrete terms varies considerably.

Although the number and types of parameters which can be represented graphically is limited in INFOTUIN/TVPC (11 parameters, see my discussion on criterion 1), the graphical module is organized in a crystal-clear manner, which -at least from an 'academic' point of view- seems perfectly logical. Each graphical overview can include a maximum of four lines. For each line, the grower is completely free to determine which parameter from which enterprise is represented. Thus, it is possible to make a graphical overview including the same two parameters of two different enterprises, but one can also produce an overview with one parameter of four enterprises, or with four parameters of one enterprise. Within the limitations of the number of parameters, therefore, growers can make a rather large number of different overviews. Hence, they have considerable freedom of choice and thereby a large responsibility for their own learning process.

In INFOTUIN/TVPC, it is not possible to include lines from different years into one graph. In order to compare their own results with those of previous years, therefore, growers need to make separate graphs; when printed (for which easy facilities are provided) these graphs can be compared.

Furthermore, the scale of the vertical axis can be manipulated in INFOTUIN/TVPC by entering the maximum and minimum values for each parameter; similarly the scale of the horizontal axis can be influenced by choosing the number of weeks which are to be included. Moreover, the graphical representations have a clear index in which each line is associated with a parameter label. Although the units of measurement are lacking in both the graphical and the numerical overviews, they can be recovered both in the electronic form for manipulating the scale of the vertical axis, and in the form through which new figures are added weekly.

The graphical facilities of TELETUIN are organized in a rather different, and less transparent manner. In TELETUIN growers can choose from four main options:

(1) Making a graphical overview including one parameter of two different enterprises.
(2) Making a graphical overview of one parameter in two different years for the own enterprise.
(3) Making a graphical overview including two or three parameters for one enterprise.
(4) Making a graphical overview for a particular week that includes several weekly parameter values concerning a selection of enterprises (including the overall average value).

Whereas option 4 exists solely in TELETUIN, options 1, 2 and 3 directly or indirectly (i.e. by comparing different printed graphs) exist in INFOTUIN/TVPC as well. Within each option, then, growers can choose between (combinations of) 24 individual parameters which are to be represented graphically. A striking difference with INFOTUIN/TVPC in this respect is that -in options 3 and 4- the combinations are predetermined; although in each option most of the 24 parameters can be represented graphically, one cannot freely decide which combinations one wishes to have in one overview.

The combinations of parameters that are chosen may seem quite obvious to a cucumber grower (the five TELETUIN growers did not bring up any problems in this respect during qualitative interviews), but for an academic with no horticultural education they are frequently not. This manner of steering means that growers who wish to make different combinations need to put two graphical overviews on top of, or next to, each other (as is the case in INFOTUIN/TVPC when it comes to comparing with previous years). A bottleneck in this respect is that TELETUIN does not include a clear facility for printing graphical overviews. Although TELETUIN includes such a print option, it is not satisfactorily indicated; although some of the interviewed growers knew of its existence, none of them was actually able to use it.

In other respects too, TELETUIN's 'processing module' is characterized by more or less severe shortcomings and inconsistencies (see box 9.7).

Box 9.7: **Shortcomings and inconsistencies in the TELETUIN processing module.**

- In the options 1 and 2, fertilization and climate parameters -unlike production parameters- can only be represented in 'difference' lines (whereby the value of parameters from one enterprise is subtracted from those of another), whereas elsewhere they are represented in an ordinary manner.
- Clear scale indicators are lacking, especially in 'difference' graphs.
- Similar parameter or menu options are referred to in different terms in different parts of the CT. The same parameter is, for example, labelled "Stuks [pieces] per m^2 prod." in option 1 and "Produktie st/m^2" in option 3. Similarly, in order to close a certain option one needs to choose "Stoppen" in certain cases and "Naar menu" in others.
- In the options 3 and 4, it is -for an inexperienced user- always a bit of a surprise which combination of parameters will be represented graphically since in the menu only one

parameter is identified. For example, when one chooses "Guldens [guilders] per m^2 prod." in option 3, one also gets a graphical line representing the average temperature per 24 hours and one representing the number of cucumbers yielded per m^2.

- In the options 1 and 2, all graphs take the form of lines. Although not included in the index, these graphs include vertical lines which apparently represent the overall group averages. In option 3, however, one of the three parameters is (for reasons that are unclear, but may have to do with maintaining readability) represented in bar graphs. In option 4 (where one would expect only bar graphs) the second and third parameter are represented with a line; it is in fact absurd to thus connect the weekly results of 30 different enterprises with a line that inherently suggests a certain development through time.
- In the options 3 and 4, a clear index is lacking; thus it is -at least for a novice- unclear which lines and/or bar-graphs represent which parameters; hence, growers are forced to identify the parameters with the help of the scale indicators.
- The scale of the horizontal and/or vertical axis cannot be manipulated, even if there is in some cases a clear need to do so.

In all, the graphical facilities of TELETUIN -although in several respects more extensive that those of INFOTUIN/TVPC (see also the discussion in relation to criterion 1)- seem to be organized in a somewhat messy and inconsistent manner.

The usefulness of graphical representations: an intermezzo

I have proposed in section 9.4, that facilities to 'play around' with registration material can enhance gradual learning processes. Clearly, the graphical modules included in TELETUIN and INFOTUIN/TVPC constitute such facilities, since they allow growers to easily access, select and 'summarize' large series of numerical values. On the basis of observations and responses obtained during in-depth interviews with ten cucumber growers who were using TELETUIN or INFOTUIN/TVPC, I will in this intermezzo elaborate on some drawbacks and advantages which are associated with the use of graphs in the day-to-day practice of cucumber growing.

When looking at a particular graphical representation most growers make an attempt to provide a causal explanation for the shape of each graphical line, often in relation to other lines and/or registration material. From a conventional 'scientific' point of view, the making of such causal interpretations on the basis of a few graphs is rather dubious; after all, the registration material is not necessarily representative, there is no experimental design or testing of significance, little standardization of measurement procedures, and the validity of a number of parameters can be called into question (see section 9.4). Hence, any causal interpretation can be contested, and is likely to suffer from the fact that intervening variables are not accounted for. In fact, growers are aware of some of these problems, even if they do not refer to them in terms of 'intervening variables', but rather in terms of a lack of relevant context information.

> "With those graphs you can maybe draw some very rough conclusions, in the strain of: "Something is wrong with the production on that enterprise.". You can never tell, however, what exactly is the matter."

> "I think that in some cases we do no longer discuss sufficiently *why* a particular picture looks the way it looks."

> "In January and February we are always relatively high on gas use. Neither with graphs relating to temperature or with those relating to awning hours I can extract why that is. We have discussed it in the group, but I still have not discovered the causes of this phenomenon."

> "O.k., those graphs are beauties, but really you should draw them yourself, from the raw figures. With those lines you loose track of the figures. For making comparisons with your own or other growers' enterprises you must know the details. Those differences per square metre can be traced back to very tiny things; those lines can easily be too rough."

Hence, the graphs -like the figures that they are composed of- are not particularly meaningful if they cannot be placed in their relevant context (see section 9.4). Also, it can be noticed again that where expectations with respect to the drawing of conclusions have been too high, growers feel disappointed.

> "They are quite easy to work with, but you need to learn how to read those graphs. In the beginning there were quite some people who found it difficult to learn, but fortunately they had a lot of support from the extension worker. I myself know exactly what they stand for, but to be honest I must admit that can't make much out of it. Many people are really enthusiastic, but I can't see it. Yes, of course I can see that Peter planted before me, but in the end that isn't new to me. It is either immediately obvious, or you can't make sense of it at all. Besides, as soon as people fail to send in their data, the whole thing collapses; officially that can't happen, but in practice people [i.e. TELETUIN users] get away with it."

Although there is always a variety of ways in which characteristics of and/or differences between graphs can be interpreted, it is quite striking that growers are relatively quick to come up with a 'satisfactory' explanation. Thereby, the impression is that growers do not only look for a 'sound' explanation, but also for one that 'justifies' their results vis-à-vis third persons (e.g. the researcher or other growers) and/or an explanation that makes them at ease with the results. Hence, I frequently observed that -when looking at a particular graph- growers quickly selected a convenient interpretation in the strain of: "Of course it is logical that my production is lagging behind, since .... (planting date, diseases, breed, type of glasshouse, etc.)."; after which -with an apparent feeling of reassurance- they quickly conjured the next graph on the screen.

In essence, one sees that growers attempt to get a handle on what they see; i.e. the graphs invite growers to think (more or less critically) about their enterprises by putting certain issues on the *agenda*. Of course, this is the case with the numerical registration material as well, but especially the fact that graphical representations make it easier to compare registration material over a longer span seems to trigger a considerable number of growers (and probably Strategic Evaluators especially) in this respect.

This built-in longer term perspective is also reflected in the frequency in which growers used the graphical module. A large majority of growers indicate that they do not use the graphical module on a weekly basis; rather they spend a few (Sunday) afternoons each year to sit behind the computer and "play with it". Few growers indicate that they use the graphs in acute crop-technical problem situations.

From the observations and interviews, it emerges that within processes of learning, the graphical representations -apart from providing an agenda- can also help growers to draw particular types of 'conclusions'. First, the graphical facilities appear particularly useful for the *reinforcement of already existing suppositions*. Thereby, the first quote presented below also shows that for some such 'scientifically looking' graphs can be rather convincing.

> "If we put water consumption against production for two enterprises, you can see that the other enterprise has a higher consumption than we have. This higher water consumption indicates that the crop is more active. Because I know the enterprise it tells me more. However, it is not new to me; I knew already that their crop always has a darker colour green, and that he always has a hot heating tube. Most importantly it is a confirmation of my ideas. I use the graph especially in order to convince my father that it is right what I say; earlier on he was hesitant to believe me."

> "We told each other: 'We have nice weather now, so in ten days we will probably have a high production.' The graph indeed showed that. It makes it easier for you to more frequently and more thoroughly look back."

> "You can, for example, put light and production together, and when things are all right you see that when the light quantity was higher, the production was higher as well."

When suppositions are violated, graphs seem to be helpful in *raising awareness that a problem may exist*, even if often it cannot be immediately pinpointed what exactly is and/or causes the problem.

> "It happens fairly often that you see strange things happening in the longer term, for example, that someone with the same temperature, ventilation and relative humidity, stokes 30 percent more gas. That can be caused by a variety of things; the glasshouse, the computer settings, the stoking facilities, the measurement method, etc. You know that something is wrong, but you don't know what."

> "When at a particular point in time my own enterprise deviates considerably from another, you start to search -for example by using the graphs- which explanations you can get above the surface. You really have to learn to get something out of it; it isn't easy. You should really meet with the grower who you are comparing with, and find out whether you can come to a conclusion together."

In such potential problem situations (which can also arise from studying the numeric overviews), graphical representations can sometimes help growers to *place individual facts in their historical context*.

> "Sometimes you see that certain enterprises produce a lot in particular weeks. The graphs help me to look up quickly what their production was in the previous period; only then you can say more about what is the matter."

Finally, the graphs can be a help for *evaluating particular periods*.

> "It is nice to look back on the whole year and see how differences have come into being. Of course, you can really dig deep into that, but I usually don't, at least not in retrospect; it is too late to change things anyway."

Conclusion in relation to criterion 9

It can be concluded that the graphical facilities can indeed contribute to processes of individual and/or collective learning. However, it must be added immediately that the interpretation of graphs is certainly not easy nor without risk. While this is true for numerical material as well, computer generated graphs seem more prone to a misleading aura of scientific quality. This means that it would be desirable for growers to get some training in the interpretation of graphs. At present such support is not provided in relation to either INFOTUIN/TVPC or TELETUIN.

The 'playing' facilities in INFOTUIN/TVPC seem to be organized in a much more transparent and professional manner than those in TELETUIN. In addition to the advantages in terms of the parameters included in it, TELETUIN, however, offers a greater variety in the types of graphs than can be generated. Moreover, while in INFOTUIN/TVPC growers have a lot of freedom in composing graphs, TELETUIN is much more structured in that it has already predetermined which combination of parameters can be sensibly put together in one graphical overview. Both approaches seem to have advantages and disadvantages; some growers appreciate a large amount of freedom and responsibility, whereas others are overwhelmed by it. Similarly, some growers like a certain amount of steering, whereas others may -after a while- feel limited. In this sense, TELETUIN is slightly more geared towards beginners. A combination of the two approaches would probably be ideal.

Although TELETUIN has certain shortcomings with respect to the organization of its graphical facilities, I would argue that -in the end- TELETUIN's overall facilities for playing around with registration material are still superior to those of INFOTUIN/TVPC, especially if one takes into account both the number and types of parameters that can be graphically represented, and the facilities for making numerical overviews (see the discussion on the criteria 1 and 2).

Criterion 15: arrangements for influencing group composition

I have already indicated in my discussion in relation to criterion 2 that, if participation in either INFOTUIN/TVPC or TELETUIN is insufficiently widespread, the space for manoeuvre for composing groups can be severely hampered. In Drenthe -where 80 percent of the cucumber growers participated in TELETUIN after two years- the situation in which negotiations can occur about group composition has already returned.

> "In the beginning the frontrunners were all together, but now the excursion-groups are mixed again in order to keep the peace. After all, everybody has equal rights to be with the best growers, for everybody goes naked."

In case of TELETUIN and the postal ERCS, group composition is wholly determined by the northern and the southern study club authorities respectively. In case of INFOTUIN/TVPC (which operates primarily in the Westland region), the group composition is drafted by NTS study club supervisors, who remain in close contact with the study club authorities. In the latter case, the extent to which individual growers especially can influence group composition may be relatively limited. Thus, it seems that regional arrangements within each study club are more important in this respect than the particularities of the specific ERCS. If, for example, the southern study club would decide to adopt INFOTUIN/TVPC they could probably remain in full charge of excursion-group composition.

Conclusion

In table 9.9, I have schematically summarized the conclusions that were arrived at in this section and/or the appendices 3 and 4.

Table 9.9: Summarized results of the comparison between two 'automated' ERCS, against the background of the characteristics and prospects of the existing postal ERCS and the design-criteria formulated in section 9.4.

	Postal ERCS	INFOTUIN/TVPC	TELETUIN
criterion 1 *	++	—	+
criterion 2 *	—	+	+
criterion 3	0	0	0
criterion 4	0	0	0
criterion 5 *	++	—	+
criterion 6	0	0	0
criterion 7	—	++	+
criterion 8	+	0	0
criterion 9 *	—	+	++
criterion 10	0	++	+
criterion 11	0	0	0
criterion 12	0	0	0
criterion 13	0	0	0
criterion 14	0	+	0
criterion 15 *	0	0	0
costs	++	0	0
continuity	0	+	0

++ = much more appropriately organized/designed than in other ERCS
\+ = more appropriately organized/designed than in other ERCS
— = less appropriately organized/designed than in other ERCS
0 = organization/design roughly equivalent to other ERCS market with '0'

On the basis of qualitative impressions and personal judgement I have marked those design-criteria that seem of vital importance with '*'.

When focusing on the five design-criteria that were identified as being of vital importance, we see that the postal ERCS has certain advantages over the 'automated' ERCS (criteria 1 and 5) but also some disadvantages (criteria 2 and 9), whereby its limitations in relation to criterion 9 (accommodating gradual learning processes) seem most severe. If this latter shortcoming would lead the southern study club to consider an 'automated' alternative, it is significant to note that TELETUIN has advantages over INFOTUIN/TVPC in relation to three of the five vital criteria. On three relatively minor criteria (7, 10 and 14), and with respect to expected continuity, INFOTUIN/TVPC has advantages over TELETUIN.

Furthermore, if the study club was to adopt an 'automated' ERCS, its members would have to take high costs and a more or less prolonged limitation of flexibility in composing excursion-groups for granted.

9.7 Initial attitudes towards 'automated' ERCS, the consequences of the study and the validation of design-criteria

As mentioned in section 9.1. this study was carried out on behalf of the Stoke-Cucumber Study Club Brabant/Limburg. The results of the study were reported to the study club in July 1990 (and in a more preliminary form in December 1989 and January 1990). The results were not only orally discussed with the Registration Committee of the study club on several occasions, but also written down in a report the contents of which resemble those of sections 9.2, 9.4, 9.5 and 9.6 in this book (Leeuwis, 1990b). Also, this report was sent to -and discussed with- DACOM and SITU/NTS staff. As I will argue later on, the contents of the report have -at least to some extent- influenced the subsequent actions of several actors in the arena. Before discussing this matter, I will first discuss the attitudes of cucumber growers towards INFOTUIN/TVPC and TELETUIN *before* the completion of the research. Towards the end of this section, I will draw some conclusions with regard to the validity of the design-criteria that were formulated in section 9.4.

Initial attitudes towards 'automated' ERCS

In the course of 1989, the Stoke-Cucumber Study Club Brabant/Limburg and other fruit-vegetable study clubs in the region were struggling with the question of whether or not to adopt an 'automated' ERCS. Especially for the cucumber study clubs, this decision was complicated by the fact that a cucumber version of TELETUIN was already in use in Drenthe. In May 1989, two demonstration meetings were held at the auction at Grubbevorst; one on INFOTUIN by SITU/NTS (TVPC did not yet exist), and one on TELETUIN by DACOM. After these meetings, the Board and Registration Committee of the Stoke-Cucumber Study Club Brabant/Limburg has explicitly informed SITU/NTS that, if they failed to provide facilities for graphical representation by September 1989, they would advise their members to adopt TELETUIN instead (RCB Brabant/Limburg, 1989). This, then, would run counter to the NTS policy to create a national ERCS for all growers, of which NTS would control the central database.

Despite the firm position expressed towards SITU/NTS by the study club authorities, there were certainly some internal divisions within the study club. Some were already highly impatient to adopt INFOTUIN or TELETUIN, while others doubted if 'automated' ERCS would really solve the problems with the postal ERCS and/or whether it would be wise to deviate from NTS policies. In this context my suggestion to do a study in relation to these matters was readily embraced; not least since it helped to delay the decision without giving the impression that nothing was being done about it.

Despite the discussions that were going on among the study club authorities, it appeared during the interviews that very few growers had a clear idea of what TELETUIN and

INFOTUIN really amounted to. The general idea was that these systems would allow faster exchange of registration material (also with groups outside the region), and help to cut back on paperwork. Some growers were aware that graphical facilities could be provided, but even then they had no clear picture of what the benefit would be. The participants of the postal ERCS seemed somewhat reluctant; five of them indicated that -despite the financial consequences- they were certainly prepared to participate in an 'automated' ERCS; two of them had no interest at all, whereas the remaining seven indicated that they might or might not participate. The non-participants were slightly more radical; five indicated that they would certainly participate, and the remaining three had no interest at all.

It is striking that few growers who argued that they might or would certainly participate gave substantive reasons (i.e. reasons that relate directly to the contents of the packages) for this; those who did are quoted below.

> "I don't mind about the fl. 7,000.- that it will cost including the PC: per square metre, and as a percentage of the total costs that is peanuts. I will buy an extra PC since I want it to be in the house. The advantage is that it stimulates you to deal more intensively with things; also because it is quicker, and because of the access to other areas in the Netherlands. Especially playing with the graphs looks interesting to me."

> "I will certainly participate. The main point is that it is quicker and easier, and that you can compare with enterprises that you don't know at all. I also think that it helps to get a better overview, and that it is easier to store data. With the climate computer I can already get fifteen graphs; with those you can look back nicely on what has happened."

> "I already have the PC for the labour registration and my daughters, so it is easy for me to participate. The big advantage seems to me that you can already study the data of the present week before you go to the excursion-group; that is, if everybody sends their data on Thursday evening. Hence, you know better what you want to talk about. (...) I don't think that graphs will be particularly useful. We once had a student who did a practical in our group. He used to make graphs of our enterprises, for example he put several climate computer settings against the openings of the windows. It appeared that -with the same settings- it could be very different. Therefore, I don't think that you will be able to extract a lot from graphs."

> "I expect a lot of it. It means that you can always look back; if something goes wrong you can always trace it back to where it started. Now it is too much work to analyze that."

Other growers have less substantive reasons for participation, but emphasize that they do not wish to be left behind; that is, they wish to ensure their (and their children's) access to those that run fastest. It strongly emerges that the presence of 'computer-literate' children and/or potential successors can indeed be an important influence and consideration for growers with respect to the adoption of CT.

> "No, I will not adopt these computerized farm comparison systems, but I will advise my son to do so. You have to be able to talk about it. That happened with the introduction of the climate computer as well; suddenly people started talking in different terms. If you don't know what they are talking about, you miss a lot of information. If you don't participate, you won't be able to communicate after a while, and that is very dangerous."

> "I have seen a demonstration of it; it is quite nice. If it became common property I would participate. It is a nice job for my son too; he already has a PC anyway. Personally, I don't really see the advantage, but you have to go with the rest, because it doesn't take long before they don't even send you the papers any more. The small group remains the most important anyway."

> "I am indeed interested, and I have a son who also wants to proceed with it. I do think, however, that the NTS should at one point state what is going to be the future, and what is safe to buy. I know of people who already have their third PC."

> "Yes, I am going to participate. My son is sixteen years of age, and wishes to take over the enterprise. For his sake I am prepared to buy a computer. I want to be up to date when he takes over. I am also going to buy a registration package. We will have to get used to those things."

Others have a positive attitude but wish to avoid having to deal with growing pains.

> "I am going to buy a PC for bookkeeping, and for the registration package I want to buy. When that has all materialized I will start to look further. If INFOTUIN is doing nicely at that moment I might participate as well."

> "When the growing pains are over I may start to participate. My thirteen year old son is a bit of a computer freak; he will have to teach me."

The growers who are quite convinced that they will not participate are those who have little interest in registration anyway, and/or those who resent the competitive character and apparently fear that 'automated' ERCS will only increase competition (see section 9.4).

> "I have heard and read it all, but I am not interested. Those guys who participate are computer freaks. It is in their nature to egg each other on. Let them say that I am getting old. I know those guys in the Westland; they show up with beautiful figures. But that doesn't mean anything to me; I want to see a crop with it, and know why it looks so badly."

> "I don't find it interesting. I am not so curious to know all those figures. Even if I know that he has cut more than I did, I still know nothing."

It is quite striking that all of the Quantity Growers indicate that they will certainly participate in INFOTUIN/TVPC or TELETUIN, versus only 16 percent of the Quality Growers (an additional 33% is in doubt) and 42 percent of the Intermediate Growers (42% is in doubt). Given the characteristics of these growers (see section 9.4), it is not surprising that there seem to be associations with size and age as well[27]. In conjunction with presumed strategic, normative, age and/or family cycle related differences (see section 9.4), this phenomenon may also be related to growers' strategies to favourably influence group composition; i.e. particular groups of growers wish to quickly adopt (or not adopt at all) because they know that this will have a (more or less prolonged) impact on group composition.

The Strategic Evaluators and Technical Fine-Tuners seem to have similar attitudes towards 'automated' ERCS (that is, their intentions to participate or not are equally distributed), whereby I have the impression that (if any) they have different expectations. While Strategic Evaluators expect greater access to registration material from outside the region, and see opportunities for making overviews over longer periods of time, the

Technical Fine-Tuners envisage a better connection with the excursion-groups and/or more thorough discussions on climatological issues.

> "Now that I am getting a PC anyway I may participate; the one causes the other, and it is going in that direction anyway. It only makes sense if you do it with the small group; maybe you can dig deeper into the climate in that way."

The consequences of the study in the actual course of events

Although it is dubious to single out a particular event (i.e. this particular study) and make an assessment of its influence on other events in time and space, I cannot given my practical concerns, purposes and questions (see section 6.2), avoid doing so at this point. I will briefly discuss some of the actions which the southern study club, DACOM and SITU/NTS have taken during and after the study, and indicate the extent to which these actions may have been influenced by it.

Already in December 1989, the Registration Committee of the southern study club has adapted its postal ERCS considerably at the end of 1989. Anonymity was lifted and presentation of registration material on the print-out was modified to suit excursion-group purposes. Furthermore, in order to improve group composition, systematic efforts were made to identify specific thematic interests, while sanctions were included to guarantee discipline. At the same time, one excursion-group (consisting of six growers) has more or less independently decided to start using TELETUIN from 1990 onwards, and a second excursion-group (consisting of seven growers) followed their example in the course of the year. Although the researcher refused to advise the southern study club on whether or not to adopt an 'automated' ERCS (and which one)[28], the southern study club has towards the end of 1990 formally decided to collectively change over to TELETUIN, despite of some technical troubles experienced the previously mentioned thirteen growers. Hence, 55 members of the southern study club (69%) participated in TELETUIN in 1991.

Although I certainly have the impression that my study has been used by the study club authorities to legitimize their decisions, the rapid adoption of TELETUIN in Brabant/Limburg (and also in Drenthe, see chapter 10) cannot only be explained in terms of its substantive advantages identified in my study. As will be discussed in chapter 10, regional sensitivities and solidarity among peripheral groups may have played a role in this respect as well. Similarly, other growers had little choice but to adopt the package if they did not want to become isolated from particular growers and discourses.

DACOM has in the course of 1990 adapted TELETUIN at several points. In the 1991 version an adequate print option is provided, and some other shortcomings and inconsistencies mentioned in section 9.6 have been corrected as well. Furthermore, the number of parameters that can be graphically represented has increased considerably and the combination of parameters included in one graph is no longer predetermined. According to the DACOM director, the research report and subsequent discussions have certainly played a role in the initiation of these changes. Similarly, I have noticed that DACOM has adopted some of the report terminology in its marketing strategy. In all, DACOM has reacted quite enthusiastically to the report (perhaps even more so than the cucumber growers), since it was felt as a long awaited recognition for their efforts; a recognition they had -at that moment in time, and in their perception- never obtained from SITU, NTS and the auctions (see chapter 10 for details). As at 1993, the report is still cherished as a memorable milestone in the DACOM-history (personal comment by DACOM staff).

Although SITU/NTS has showed an interest in the report, they have -at least initially- not paid much heed to the report and its recommendations. Given the institutional arrangements around INFOTUIN/TVPC (see chapter 10), the implementation of the recommendations would have had major financial consequences, and was therefore virtually impossible. Also, in 1990 the NTS was already considering the building of a totally new 'automated' ERCS of which they would control only the central database, while local compatible 'processing modules' were to be provided by several commercial software firms. Hence, in their experience, the results of the study were already somewhat outdated, and not their primary concern since the provision of adequate 'processing modules' would -in the future- no longer be their responsibility.

However, at least partly in conformity with the design-criteria identified in the study, NTS has -together with commercial software developers who explicitly asked for (and received) a copy of the research report- designed the new central database in such a way that all excursion-groups have almost complete freedom to determine which parameters they wish to include. That is, they can select such parameters from a crop-specific 'data dictionary'. In order to fully realize this potential in practice, NTS has agreed with the commercial software firms that they will develop their 'processing modules' as 'empty' shells which can be filled up by growers according to their specific crop and interest.

Anticipating these changes, SITU/NTS have -one year after its introduction- stopped the promotion of TVPC towards the end of 1990. INFOTUIN has continued to exist until the end of 1992, and was then replaced by the new 'automated' ERCS named GROEINET ('groei' means growth).

Validation of design-criteria

I have concluded in section 9.6 that -although the superiority of 'automated' ERCS can be considerably shaded- TELETUIN has a few important advantages over INFOTUIN/TVPC in terms of the design-criteria that were formulated. Hence, it makes sense to take the relative success of the two packages as a rough indicator of the validity of these criteria.

In relation to this, it is important to note that the high adoption percentage of TELETUIN in the southern context (69% of the study club's members one year after its introduction in the region) was neither short-lived, nor unique. In 1993, the number of participating cucumber growers in the region had increased to 75, which -due to amalgamation of the Stoke-Cucumber Study Club Brabant/Limburg with the Hot-Air-Cucumber Study Club in the same region- amounts to 62 percent of the 120 members, and 69 percent of the then 108 stoke-cucumber growers. (An additional eight cucumber growers participate in a postal version of TELETUIN, while eleven growers continue to use the previously existing postal ERCS.)

When GROEINET was introduced towards the end of 1992, the study club authorities have proposed to change over to a special version of TELETUIN which was made compatible for GROEINET. However, after testing this version, the southern growers concluded that the communication with GROEINET was too problematic, and that the available data dictionary was insufficiently elaborate. Hence, they preferred to continue to use DACOM's central database and the original version of TELETUIN.

In the cucumber enclave in Drenthe -where TELETUIN has its origins (see chapter 10)- TELETUIN has been quite successful as well. After two years of operation 28 cucumber growers (70% of the total) participated in TELETUIN in 1990. In 1993, 33 cucumber growers (82%) participate in this enclave.

In the west (Westland and De Kring) -the homeland of INFOTUIN/TVPC- such regional percentages are out of the question. Although in 1991 study club supervisors estimated that 50 cucumber growers (approximately 25%) used INFOTUIN, only ten (5%) had bought TVPC.

In all, it emerges that especially the adoption of TELETUIN by some growers has -at local level- induced the quick processes of (technological) *re-homogenization* that I have discussed in section 9.4. If one accepts that 'the proof of the pudding is in the eating', I think that it is legitimate to claim that -at least in relation to cucumber growers- TELETUIN has been much more successful than INFOTUIN/TVPC. Furthermore, this relative success can be plausibly explained in terms of the extent to which the two packages meet the design-criteria that I have formulated while analyzing social practices in section 9.4.

9.8 Theoretical and practical implications (part 2)

As I have done in chapter 8, I will use the final section of this chapter to 'make up the balance' by discussing the practical and theoretical issues and implications that arise from my second case-study. Again, I will structure this section around the envisaged practical contributions (and related guiding questions) which have led me to select it (see sections 6.2 and 9.1). In order to avoid duplication, I will (unless I have gained new insights or omitted them in chapter 8) not try to address all the individual guiding questions again; instead I will basically pick up the discussion were I left off in section 8.6.

On developing relevant empirically-based classifications of horticulturists (part 2): towards multiple classifications of diversity

In this case-study, I have used a much more simple approach towards classification than in the first case-study (see chapter 8). I have not asked growers to discuss diversity along dimensions that were introduced by the researcher, and neither have I gone through a extensive procedure of making multi-facetted portraits, identifying the extent to which growers recognize themselves in these, and applying discriminant analysis to arrive at a final classification. In fact, I have not even tried to arrive at an overarching classification in the first place. Instead I generated *several* classifications, two of which are defined in terms of (attitudes towards) very concrete practices which are connected with a specific field of interests (enterprise registration and comparison). The third classification is not directly defined in terms of diverging practices which constitute enterprise registration and comparison, but -in a similar vein as the farming styles classification- emerged on the basis of initial discussions with growers, and is rooted in practices of a different type, i.e. concrete production practices and strategies.

Even if the assignment of the growers into the various categories was based on the basis of growers' responses to particular questions, it would be misleading to say that growers have classified themselves and/or that we can speak of an ethno-taxonomy. In essence, the classifications made were (even if empirically-based) researcher defined.

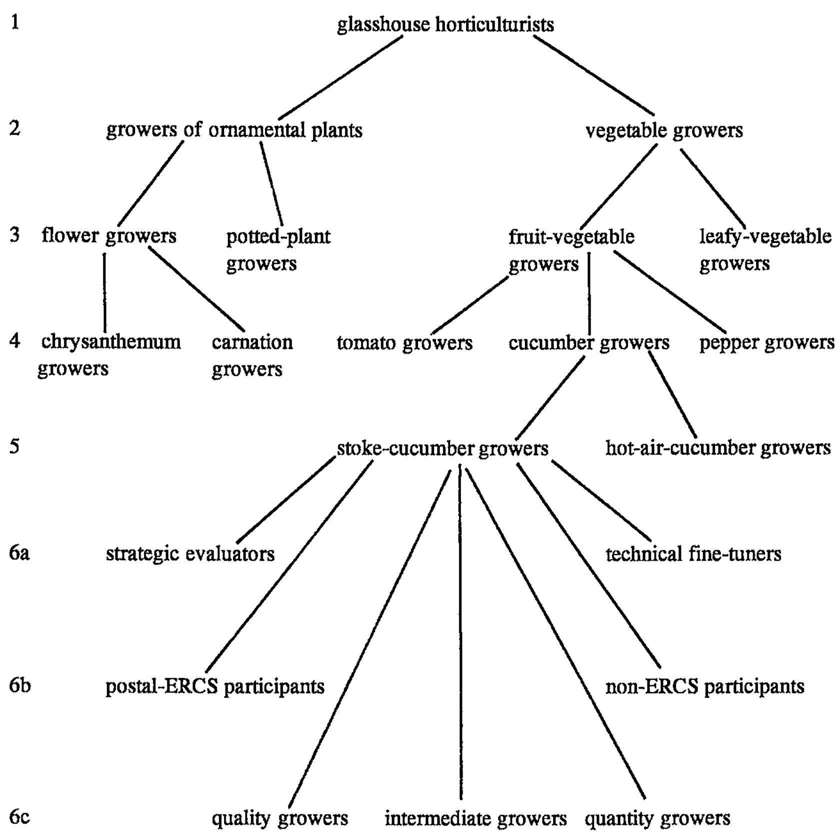
Interestingly, it appeared that a further quantitative and qualitative exploration of *all three* classifications has not only considerably increased my understanding of the social dimensions of enterprise registration and comparison activities, but has also helped me to identify plausible design-criteria for CT-development, which seem to be of direct relevance to practitioners in this particular context.

Clearly, since -especially in horticulture- sets of practices can rapidly change over time, it is unlikely that this approach towards classification leads to the generation of stable classifications (guiding question 5). In fact, since the classifications are based on isolated (sets of) practices, they may be even less stable than the classification into farming styles. Nevertheless, I am of the opinion that my search for classifications on the basis of knowledge-related practices, and my subsequent explorations of these, has given me a sharper insight in different rationalities, knowledge networks, communication patterns and CT-use (guiding question 3), than appeared possible with the help of the classification into styles of farming (see my discussion in section 8.6).

Partly in relation to this, but mainly because of my focus on enterprise *comparison* practices, I think that -even if this was not my prime interest- I have deepened my insight into how diversity is socially constructed (guiding question 2). It has emerged at several points in my analysis, for example, how: (a) participation in particular social networks; (b) specific geographical locations; (c) illegal practices; (d) the presence of children; (e) health problems; (f) regional interconnections; (g) age-related normative convictions; and (h) competition and/or negotiations among growers, may have consequences with respect to growers' access to other growers' experiences and/or registration material. This differential access, then, is likely to affect the ways in which they further develop their enterprises. Thereby, it seems that both growers' uncertainties (and the subsequent copying of practices) and unintended consequences of action, seem to play a much greater role in the production of diversity than I have acknowledged in chapter 8, where I have essentially explained diversity primarily in terms of more or less explicit strategic considerations.

The observation that growers can be classified in various ways, which all bear relevance to the design of a particular CT, only adds to the problematic aspects of current approaches towards the identification of 'homogeneous target-categories' (see section 8.6). Although many extension scientists would agree that -strictly speaking- a target-category can never be 'homogeneous' they continue to use the term in order to underline that practitioners should orient their interventions towards a relatively 'homogeneous' audience. On the basis of this case-study, however, I would propose that it is probably more helpful and appropriate to argue that -at least in the case of agricultural and horticultural CT- practitioners should explicitly direct a particular CT towards a cross-section of different target-categories that is composed in such a way that the existing diversity can be realistically accommodated in one internal CT-design. I will illustrate the significance of this statement with the help of a target-category tree which includes the various categories of growers that we have encountered in this chapter.

Figure 9.1: A target-category tree of potential target-categories in glasshouse horticulture.



In essence, my case-study shows that INFOTUIN/TVPC was aimed at level 3 (fruit-vegetable growers), but was designed (both internally and externally) in such a way that it was unable to adequately accommodate the diversity at the levels 4, 5 and 6. In contrast, TELETUIN was directed towards level 5 (stoke-cucumber growers), and was indeed successful in meeting the diverse demands associated with the levels 6a, 6b and 6c.

In fact, it can be argued that in the time-space context of 1989, it was -given both the limited experience with 'automated' ERCS, and technological, financial and institutional constraints- unrealistic for SITU/NTS to expect that an adequate 'automated' ERCS could be developed at level 3. As at 1993, the chances of doing so have increased (as the development of GROEINET shows; see for details chapter 10). This leads me to hypothesize that innovations are most likely to be successful if they are -at least initially- thoroughly explored at lower levels in a (context-specific) classification tree.

From the above discussion, it again emerges (see also section 8.6) that anticipating diversity in CT-design is indeed important (guiding question 4). While I have argued in relation to DELAR-like CT that the scope for anticipating diversity is largest in the external design, I have shown in section 9.6 that, in the case of ERCS, there are various opportunities in the internal design as well. This seems to be related to the fact that DELAR can be described as a cross-breeding between a Feedback System and an Extension Worker Supporting (or Replacing) System (see section 7.3) which includes highly complex (and inherently rigid) models of socio-economic, natural and technical processes, opportunities and constraints. In contrast, 'automated' ERCS are merely a cross-breeding between a Feedback System and a Network System which includes only parameters rather than models that somehow concern the interrelations between them. One might conclude, therefore, that as the complexity of a CT increases (in terms of the models of natural, technical and socio-economic processes, opportunities and constraints that are incorporated), the anticipation of diversity more and more depends on an adequate 'external' design. The same holds -in relation to guiding question 7- with respect to the integration of knowledge from different epistemic communities.

In sum, it can be concluded that -for analytical purposes- it is relevant to develop a variety of practice-based classifications of farmers that are *specific* to a particular *intervention context* (guiding question 6). After making a qualitative and quantitative profile of each category, and gaining an understanding of the social nature of relevant practices, it may be possible to identify an appropriate level of diversity for which a 'standard' CT (in terms of its internal design) can be realistically constructed (guiding question 4). For some categories of farmers, then, the internal design will have to be accompanied with special arrangements in the organizational sphere (see for example the importance of the excursion-groups for Technical Fine-Tuners).

Design-criteria for facilitating the integration of knowledge from different epistemic communities (part 2): on climate computers, changing practice and the emergence of a new discourse

In general, it can be argued that the research methodology, and my approach towards classification and case-study selection, have helped me to formulate a greater number and variety of criteria for CT-design than those arrived at in chapter 8 (guiding question 11). In addition, these criteria are more concrete and context-specific as well.

When looking more specifically at the issue of integrating knowledge from different epistemic communities into one CT, it seems that -in the context of ERCS- we are speaking primarily about integrating knowledge from different *grower communities*, rather than about integrating scientists' knowledge and growers' knowledge. In section 9.4, I have generated various design-criteria that directly relate to this issue (e.g. criteria 1, 2, 3 and 4).

At second thought, however, it cannot be maintained that an 'automated' ERCS only 'includes' knowledge from different grower communities; in fact one sees that -indirectly-scientists' knowledge is incorporated as well. This is particularly so since ERCS include a number of parameters in relation to climate and fertilization, which are directly related to the widespread use of (computer-based) technologies for the regulation of climate and feeding. Hence, the thinking and talking about the enterprise in terms of such parameters has emerged along with the adoption of these technologies, whereby "suddenly people started talking in different terms". As the following quotes indicate, these technologies incorporated modes of thinking which were alien to growers. It also emerges that with climate computers too, there are all sorts of problems relating to standardization and diversity.

> "The big question to me is still: How do I get my climate the way I used to have it previously? The computer is still not perfect. The problem is also related to all those different crops. You need as many climates as there are crops. The climate computer needs to be able to create 1000 climates, and moreover a cucumber grower wants to make different refinements than a lettuce or flower grower. Besides, they have to deal with different types of glasshouses, each with their peculiarities, cold spots, etc., and the question is how to resolve all that. (...)
>
> In the early years I have cursed the computer continuously because of the fact that is was so difficult. Now it has at least become reasonably user-friendly. The problem was that it had been assembled by engineers, so that I had to program it at the level of the engineer, and I wasn't able to. *Each time there was this collision when I had to go to the engineer with a stupid question, and then he always replied with a stupid question as well.* Sometimes it was too simple for words. Gradually, it has more or less become all right."

A cucumber grower who has recently built a completely new glasshouse, and has for the first time bought a climate computer, experiences similar problems:

> "I had a lot of trouble in the beginning. Everything is new; the substrate, the crop, the stoking facilities and the climate computer. In have had strong temptations to throw the climate computer through the windows. You have to learn to understand the machine. I wanted the ventilation to be independent of the temperature in order to keep an adequate level of humidity, but I couldn't figure it out. You can see exactly what climate is there, but you get so much information, and there are so many settings which can be manipulated that you become crazy."

It seems that the introduction of the climate computer has had major repercussions in horticulture; not only have growers' practices changed, but also their modes of thinking and discourse. Before the climate computer growers were, for example, 'manually' and independently manipulating the windows and the stoking facilities in order to create an optimal temperature and humidity. Nowadays, they can (or have to) program a particular temperature and humidity, and then the computer determines how wide the windows can be opened, and what temperature the heating tubes will be (i.e. the dependent and independent variables have -from the perspective of the growers' interventions- reversed).

Frequently, it happens that growers wish to correct the computer in the way it tries to achieve a particular climate, and sometimes they have to 'mislead' the computer and use artifices to do so. For example, if a grower wishes to increase the opening of windows, (s)he may (depending on the climate computer) have to manipulate the temperature and humidity settings, since it is impossible and/or unpractical to directly steer the windows. Even then, the computer may -depending on wind-speed, measured light quantity, stoking level, etc.- surprise the grower, and still not 'decide' to increase the opening of windows. Hence, growers have to put themselves in the modes of reasoning that are implemented in the models underlying the climate computer.

As at 1993, the impression is that the modes of thinking employed in climate computers have, to a considerable degree become, integrated in growers' previously existing frames of reference. In fact, it can be argued (with reference to the discussion on different types of knowledge in section 5.1) that many growers have developed considerable skill, craftsmanship and/or 'l'art de la localité' in manipulating climate computers.

Clearly, intensive collective and/or individual learning processes have (also on the side of climate-computer developers) preceded this state-of-affairs, and enterprise registration and comparison activities have probably been of considerable importance therein. In that sense, 'automated' ERCS can indeed facilitate an adequate integration of knowledge from different epistemic communities. In conformity with the insights arrived at in relation to DELAR (section 8.6), therefore, it can now be concluded more generally that in order to achieve such integration, it is important to design CT (both externally and internally) in such a way that they can serve as an agenda for discussion, and facilitate (joint) processes of learning. The example of the climate computer shows clearly how such learning processes constitute a process of 'structural change'; that is, the resources, normative rules and rules of interpretation that actors draw upon are modified and renegotiated to such an extent that new structural properties emerge.

The potential contribution of (and to) extension workers (part 2): on having different (rather than different levels of) expertise, revisited

In this case-study, extension workers have so far not emerged as important actors in enterprise registration and comparison activities. In part, this is a somewhat distorted view, since -at least until the privatization of the extension service in 1990- extension workers have been active in stimulating enterprise registration and comparison activities, and have even performed organizational tasks in this respect.

In relation to the southern study club's postal ERCS, the local extension worker would usually be present as an advisor at meetings of the Registration Committee, and would take care of some logistics as well (guiding question 12). Furthermore, I will show in chapter 10, that an extension worker has played a major role in the development of TELETUIN too. Moreover, I have in section 9.4 identified various criteria for the external CT-design which may be effectively fulfilled by extension workers (see appendix 3). Apart from providing general organizational and administrative support to study clubs, they could be particularly useful in providing training to discussion leaders (in how to achieve a balanced integration between ERCS-related activities and regular excursion-group functions) and ERCS participants (in how to draw adequate conclusions on the basis of registration material, either graphically represented or not) (see criteria 11 and 14). Hence, we see again that there is considerable scope for extension workers to serve as discussion partners and/or perform training functions for growers who work with CT (guiding question 14).

As I have stressed in section 8.6, however, it remains important to look at growers and extension workers as actors who bring in a different expertise, rather than as actors who have different levels of expertise in the process of finding the most adequate interpretation in relation to issues raised on the basis of registration material. For horticulture, this seems especially relevant, since -quite generally- growers tend to be sceptical about the technical expertise of the employees of the former public extension service and its privatized successor (see also Van Aaken et al., 1990:89-90).

This observation leads me to the contribution of ERCS *to* extension workers rather than the other way around. It is probably safe to say that extension workers have as much (or even more) to learn from participating in ERCS-related activities as growers. For them too, such participation can help to keep track of the turbulent technological developments in the horticultural sector, and -especially if they operate in different regions- it can help them to maintain their role as brokers who bring in experiences from other growers outside the region (see section 9.4).

Towards an inductive methodology for identifying information needs (part 1): coping with the emergent character of information needs

As I have mentioned in chapter 2, the question of what the 'real information needs' of farmers and horticulturists are is increasingly occupying agro-informaticians. In the information managements studies literature, it is quite common to speak of four strategies that can be applied for determining information requirements in relation to the development of 'information systems'. Davis & Olson (1985:480ff) and also Bots et al. (1990:156:ff) describe these as:

(1) asking the users;
(2) deriving from one or more existing information systems;
(3) synthesizing from characteristics of (existing ways of information gathering in) the organization (or 'utilizing system');
(4) discovering from experimentation with an evolving information system.

According to Davis & Olson (1985:488ff), an appropriate strategy can be chosen on the basis of the overall uncertainty in relation to information requirements. This overall uncertainty depends on the characteristics of: (a) the organization (level of stability; well or badly defined); (b) the would-be information system (level of complexity); (c) the users (number; level of experience); and (d) the information analysts (level of training and experience). These characteristics, then, are connected with different levels of uncertainty with respect to: (a) the existence and stability of a usable set of requirements; (b) users' ability to specify requirements; and (c) analysts' ability to elicit requirements and evaluate their correctness and completeness.

As overall uncertainty increases, Davis & Olson (1985:489) suggest that the different strategies for determining information needs become more appropriate in the order in which I have presented them above (1: asking ..., 2: deriving ..., 3: synthesizing ..., 4: discovering ...). Furthermore, they argue that the level of knowledge and experience that analysts need to have for employing these strategies is relatively low for strategies 1 and 4, and relatively high for strategies 2 and 3[29].

As has emerged in both the case of DELAR (which in my experience is by no means an exception) and in chapter 7, farmers' information needs have so far been primarily defined by researchers and software developers (guiding question 17). In terms of Davis & Olson, these agro-informaticians have primarily employed the strategies 2 and 3 (which -if we look at an 'information system' in a less technical sense- are practically identical). This is, for example, reflected in the development of Standard Information Models (see section 7.4), and the widespread use of especially 'process-oriented', 'data-oriented' and 'project-oriented' methods of CT-development in general.

Even if not necessarily inherent in these methods, agro-informaticians have thereby adopted a rather *deductive approach*; that is, information needs were in practice deducted from available scientific knowledge, formal rational decision-making models, legal regulations, the researcher's normative convictions, etc. Also, we see that these information needs are often operationalized as very specific *parameters* and *norms* (see chapter 8).

In relation to such parameters, this case-study has provided some insights. First, I have shown that -at least in horticulture- the parameters that growers are interested in are not only diverse, but also subject to rapid change. Although it has emerged that there may exist a certain amount of stability with respect to both the knowledge and information-related *practices* that growers engage in and the *types of* parameters that growers are interested in, it has also become clear that running an horticultural enterprise involves a process of learning, in which the *specific* parameters that growers wish to examine are continuously reshaped by one's own and other growers' experiences and results, the availability of new technologies, rumours, trends, and contextual changes (guiding question 16).

Linking up with guiding question 15, it has emerged that such learning processes are clearly social in nature, which means that the information needs that arise in it are associated with normative considerations and conflicts, competition among growers, political struggles concerning group composition, etc. Moreover, I have shown that in the process of learning, growers do not usually have well defined information needs and/or problems, but become curious about certain things while browsing through the registration material in a rather undirected fashion. In many ways, learning among horticulturists seems to be a routine-like activity, in which growers 'invent' problems that are merely problems of interpretation and explanation, which may (or may not) sooner or later become of relevance for the making of concrete decisions. Lastly, as appeared to be the case with DELAR, it seems that the provision of particular parameters frequently raises more questions than it answers, and urges growers to search for additional (context) information.

In all, this case-study has shown that any CT that wishes to support such learning processes by means of providing parameters, needs to be flexible, adapted continuously, and grounded in the day-to-day experiences of growers. These and other considerations (see sections 2.2, 7.4 and 7.5) lead me to doubt the extent to which information needs can be adequately deduced from the models adhered to by researchers and software developers. Therefore, I propose that deductive methods need to be -at least- complemented by *inductive methods*. When using such methods, it must be acknowledged that -in many cases- it is not very fruitful to directly ask farmers what their 'information needs' are. Due to the routine-like fashion in which information needs arise and are solved, growers and farmers are usually not discursively aware of their information needs. Moreover, it is even harder to make these requirements discursive in relation to the characteristics of an abstract and unfamiliar communication technology.

Brittain (1982:141) -in a similar but more refined and empirically oriented vein as Davis & Olson- identifies four methodological approaches towards user-research:

(1) direct inquiry of users about sources of information they actually use (extent, including purpose, success and effect);
(2) assessment of attitudes of users vis-à-vis (real or imagined) information sources and services;
(3) the evaluation of experimental information services;
(4) direct observation of users in operational situations.

Although in this case-study I was especially interested in broader design-criteria that an 'automated' ERCS would have to meet, the methodology adopted has certainly helped to identify both very specific information needs that growers had at a particular point in time, and several *types of* information that growers are interested in over a relatively prolonged period. This suggests -in relation to guiding question 17- that a focus on growers' existing *knowledge and information-related practices*, and their rationalizations in relation to these (essentially a combination of the approaches 1, 4 and -to the extent that existing practices involve an 'experimental information service'- 3, as mentioned by Brittain) may be of particular use if one wishes to identify 'information needs' in an inductive manner.

However, in my view, the usefulness of focusing user-research on the identification of *specific* information needs is limited, for in many cases such needs are far from stable. This study indicates that user-research efforts might be more fruitfully directed at identifying: (a) regular knowledge and information-related practices; (b) appropriate *tools* that could support such practices; and (c) the criteria that such tools might have to meet. Furthermore, the case-study suggests that, as experience which such tools increases, the identification of more specific needs (e.g. at the level of the parameters that need to be included) becomes simply a matter of *listening* to growers, and does not require sophisticated types of user-research. More in general this brings me to the questions of how -in a particular context- *user-research* and *user-participation* can be integrated and balanced out in processes of CT-development (i.e. practical contribution 5). I will deal with that issue in chapter 10.

In relation to Davis & Olson's four strategies for identifying information requirements, this case-study provokes the following final reflection. If it comes to the identification of appropriate CT-based tools for farmers and horticulturists, it is clear that -in terms of the criteria mentioned by Davis & Olson- one can speak about 'high uncertainty' situations. Also, this case-study indicates that such identification efforts might fruitfully involve in-depth qualitative interviews with users about their practices. Hence, it follows that -in contrast to Davis & Olson's argument- 'asking users about their information requirements' is neither a method that is particularly useful in situations of 'low uncertainty', nor an activity that requires limited skills. Rather I would argue that -*especially* in 'high uncertainty' situations- it can be a crucial method, which requires different rather than less skills than those that Davis & Olson seem to take into account.

The social scientist and the production of social change (part 2): on mutual enrolment, committed impartiality and independence

In relation to this case-study, I have made plausible that -in contrast to the one presented in chapter 8- the activities of the researcher did indeed lead to: (a) a greater number and variety of practical conclusions, and (b) a greater impact of these in the actual course of CT-development events (see section 9.7). In part, this can probably be explained in terms of the researchers' intentions, and the conditions for case-study selection that were formulated in relation to this (see sections 8.6. and 9.1). In more abstract terms, and in the context of the debate on the potential practical implications of using an actor-oriented approach (see section 5.1), several characteristics of this study were crucial for the emergence of both practical conclusions and consequences.

First, it is interesting to note that the southern study club and the researcher were 'enrolled' (Latour, 1986; Callon, 1986a)[30] by each other. Both parties had their own specific 'projects' for which they found it beneficial to establish a relationship with the other, and thereby get access to, and mobilize, certain resources. From the perspective of the southern study club, the researcher had the time, money and other resources to produce possibly valuable information, while at the same time the research was a suitable instrument to temporarily remove some of the pressures that confronted them (see section 9.7). The study club, in turn, allowed me access to an interesting case-study.

For the purpose of making a content analysis of both INFOTUIN/TVPC and TELETUIN, the researcher successfully attempted to 'enrol' SITU/NTS and DACOM as well. For these organizations, cooperation was of interest since it would: (a) give them access to the research results; (b) thereby provide them with detailed information and analyses on the nature and use of the 'automated' ERCS that was developed by their competitor; and (c) make sure that the southern study club would be provided with detailed information on their package. Moreover, DACOM had a clear interest to be put on the 'Wageningen' map, while for SITU/NTS cooperation had to be decided upon in the context of longer-standing relations between the Department of Extension Science and NTS.

What is important here is that the researcher became part of *previously existing projects* of a particular local group, and hence the researcher's own project was embedded in an ongoing historical process, without intending, assuming or representing this event as "a discrete 'project' in time and space" (Long & Van der Ploeg 1989:228). Long and Van der Ploeg (1989:228) argue that existing models of intervention often isolate intervention "from the continuous flow of social life and ongoing relations", but that understanding intervention and its consequences is impossible without including time and space dimensions. Largely implicit to this perception is that many of the failures, detrimental consequences and discontinuities resulting from development policies, can be partly explained by the misunderstandings that result from its discrete image. It logically follows then that a better understanding of social and historical contexts could indeed improve intervention practices. Getting involved in local projects may in some cases be a suitable strategy to avoid such social and historical 'disconnection'. Thus, getting enrolled in historically rooted local projects, is -from a qualitative point of view- rather different than initiating an external 'cargo' project (Long and Van der Ploeg 1989:230), and subsequently becoming enrolled in a variety of projects that actors formulate in relation to it.

Second, the researcher made a clear political decision about who (apart from himself) were to benefit from the research: i.e the members and authorities of the Stoke-Cucumber Study Club Brabant/Limburg. My theoretical framework implies -in relation to guiding question 23- that the political issue can never be avoided in practically oriented research. Other approaches to intervention that try to identify explicit purposes or beneficiaries in their method, such as the Soft Systems Methodology (Checkland, 1981) and RAAKS (Engel & Salomon, 1993), tend to be oriented towards reaching an (institutional) consensus (see sections 3.3 and 4.2). Apart from the problems associated with attributing social systems with a mission (see Leeuwis, Long & Villarreal, 1990:22-23) such a consensus does not - even from the institutional point of view- guarantee successful results. As I will show in chapter 10, it can be argued that in the case of INFOTUIN/TVPC, it was exactly the effort to create institutional consensus that obstructed the development of an adequate innovation.

While taking a political stance, however, I think it was important that the researcher maintained an impartial position (see section 6.3). The researcher has refused to give direct advice to the southern study club on which (if any) 'automated' ERCS should be adopted, and has equally provided DACOM and SITU/NTS with feedback. Similarly, INFOTUIN/ TVPC and TELETUIN have been analyzed with the same scrutiny, and on the basis of the same criteria. The prime consequence of the political choice was that it influenced the *issues on which* understanding was required, and therefore the social practices under consideration. In fact -and this is my third point- the central *practical* problem statement was formulated by the study club; if the principal research question had been formulated by say SITU/NTS or DACOM, the research would probably have had a totally different focus. Hence, I would -in relation to guiding question 25- argue that researchers who wish to make a practical contribution will have to choose in whose interest such contributions should be, and make sure that the practical problem statement of the study is based on what these beneficiaries see as a positive contribution.

Fourth, I think that my methodological approach (see section 6.3) has been important for arriving at practical conclusions. Growers simply liked talking about their practices and could easily see a connection between their problems and the questions asked.

Finally, in my experience, the researcher's political and methodological choices could not have been easily made if the researcher had been working for a third party. My position at Wageningen Agricultural University allowed me to relatively cheaply, flexibly and independently conduct a study on behalf of the southern study club. Clearly, the southern study club would not normally have the resources to employ a researcher for a five-month period, and if the researcher had been employed by one of the more moneyed actors in the arena it is likely that the researcher would have had to serve other interests. Hence, this type of research for a less endowed organization seems to require special organizational and financial arrangements with respect to the relation between the researcher and client (guiding question 26). (In the Netherlands, such arrangements are in some cases provided for by so-called 'Science Shops' (Wetenschapswinkels)[31].) I will further elaborate on such arrangements in the context of proposing a CT-development method in which social scientists play a significant role (see chapter 10).

My wish to develop such a method originates from my conviction that, if the design-criteria which were developed on the basis of the study of practices relating to the *pre-automation* situation had been somehow available *before* the actual development of TELETUIN and/or INFOTUIN/TVPC, the developers of these packages might have benefitted considerably. Hence, in my next chapter I wish to explore how INFOTUIN/TVPC and TELETUIN were in practice developed, so that conclusions may be arrived at with respect to how social scientific research activities of the type that I have carried out in this case-study, can be integrated in CT-development methods and procedures.

Notes

1. In the early days many excursion groups limited themselves mainly to the exchange of technical parameters, such as climate parameters, disease control and production figures. The production figures, in which a large variation existed, where not always trusted, and this was felt to hamper severely the possibility to draw conclusions. In recent times, members of excursion groups have agreed that auctions will provide the 'correct' production figures, and in some cases, growers exchange labour and even economic parameters as well.

2. SITU is one of the semi-state branch organizations that came into being as a result of INSP-LV activities (see chapter 7). In the horticultural sector, NTS quickly jumped into the policy-created institutional vacuum (see section 7.1), and -without much consultation with its members- erected SITU; more than likely in order to get some control over the subsidies that were going to be distributed in the context of INSP-LV.

3. At the same time, experimentation would imply considerable investments (PC, modem and software) for a considerable number of growers, and would damage the functioning of the present system.

4. The critical reader will note that, although for editorial reasons this second case-study is presented as chronologically following the first, the fieldwork for the two case-studies has -in part- overlapped. The 'second' case-study took place after the series of qualitative interviews for the 'first' case-study (summer 1989), but some of the fieldwork for the 'second' study preceded the survey that was conducted on behalf of the 'first' case (November 1989). Since some of the shortcomings of the approach adopted in the 'first' case-study were (and/or became) appârent already after the qualitative interviews and during the preparation of the questionnaire, it is to some degree justified to say that the results of the first case-study have guided me in selecting the 'second'. Nevertheless, as already pointed out in chapter 1, it cannot be denied that my way of presentation implies some 'reconstruction' of actual procedures, which is convenient for constructing a seemingly coherent story in the text.

5. 'Hidden' to the extent that the growers were not aware of all 'scientific' questions that were at stake, although they were aware of the fact that the research was part of Ph.D. research.

6. NTS is organized along different lines (administrative, crop and thematic) as well as different levels (local, sub-regional, regional and national).

7. It is worth noting here that other horticultural zones within Holland are, to a lesser extent, a focal point for competition as well. This emerges most clearly from my elaborations in chapter 10.

8. The costs of many other production factors (land, labour and energy) do, at least in theory, put the sector in a disadvantaged position. Similarly, the necessary investments in technology, as well as costs related to the Dutch inheritance regulations and practices, are often much higher then elsewhere in Europe.

9. Despite the fact that biological treatments (like ichneumons) were becoming increasingly important at the time (1989), no parameters had been included in relation to this.

10. Apprehensions, according to Kolb (1984:43) refer to all those things we "know instantaneously without need for rational inquiry or analytical confirmation". By means of comprehension "we introduce order into what would otherwise be a seamless, unpredictable flow of apprehended sensations, but at the price of shaping (distorting) and forever changing that flow." (1984:43). Thus, Kolb argues that comprehensions are models that last much longer than apprehensions and which can transcend time and space by means of communication (1984:43).

11. Kolb (1984:52) proposes that transformation processes of intention and extension can be applied to both concrete apprehensions and symbolic comprehensions. In relation to apprehensions he argues, for example, that: "We learn the meaning of our concrete immediate experiences by internally reflecting on their presymbolic impact on our feelings, and/or by acting on our apprehended experience and thus extending it" (1984:52). In order to illustrate this, he uses the example of a rose, which we can intentionally observe, smell and reflect about, but which we can also take in our hands, and find out that it has a thorny stem.

12. For example, that the different questions are formulated in very similar terms, so that in fact some of the questions can hardly be distinguished from each other. Moreover, for each of the twelve questions the order in which the answer categories (which supposedly reflect an orientation towards 'feeling', 'thinking', 'doing' or 'watching') are presented is fixed.

13. That is, the questions relate to the context of 'learning' in general, but not to learning in a specific context. In cooperation with Kees Bink, I have developed a more contextual set of questions (based on Kolb's dimensions) which was tested by Bink. Bink's field experiment indicates that there was no significant difference between the outcomes of Kolb's LSI test and our alternative (see Bink, 1993).

14. Although a relatively large proportion of Technical Fine-Tuners (33% versus 25% for Strategic Evaluators) explicitly chooses quality production, we cannot directly associate them with this, since a relatively large proportion of them orient themselves to quantity production as well (22% versus 8%). The remaining growers take a middle position (see section 9.4 for details).

15. Similarly, 33 percent of Technical Fine-Tuners discontinued such a contract at an earlier stage (versus 8 percent of Strategic Evaluators).

16. These enclaves are Asten, Asten-Heusden, Helenaveen, America and Maasbree.

17. Three of the remaining four non-ERCS participants participate in the excursion groups on a regular basis; of the ERCS participants 100 percent participate regularly.

18. An additional 29 percent of ERCS participants have in the past discontinued such a contract, versus 0 percent of non-ERCS participants.

19. A limited number of growers deny that there is such a tension; according to them the two can be reconciled when cucumbers are grown in three (instead of two) plantings a year.

20. The number of weeks that growers grow cucumbers varies. For example, growers that grow three crops instead of two tend to have a longer total growing season. Similarly, one Quantity Grower and one Intermediate Grower grow tomatoes in the second half of the year. For analyzing the extent to

which the different production strategies are reflected in practice, it seemed most appropriate to divide the cumulative year results by the number of weeks in which cucumbers are grown (or more precisely: are sold at the auction).

21. Of the non-ERCS participants 25 percent seem to favour a certain degree of heterogeneity versus 43 percent for ERCS participants. For Quantity Growers, Quality Growers and Intermediate Growers these percentages are 25, 33 and 42 percent respectively.

22. Those growers among the fourteen ERCS participants -of which production figures are available- who argue that they are satisfied with their heterogeneous excursion group (heterogeneous/positive, n=6) yield on average fl. 1.64 worth of cucumbers per m^2 per week, whereas this is fl. 1.80 for those who indicate to be in favour of more homogeneous groups (heterogeneous/negative, n=4 plus homogeneous/positive n=4) ($T = -1.13$; $p = 0.28$).

23. In a personal comment (1993), a NTS employee made a distinction between 'knowledge developers' (who would prefer to be in a particular group for about five years), 'information exchangers' (who are seriously engaged in enterprise registration and comparisons) and 'passive profiteers' (who mainly participate because they want access to other growers' enterprises and registration material).

24. As mentioned in section 7.2, this is the dominant form of videotex use in glasshouse horticulture. In addition to this service, INFOTUIN also allows participants to send messages to others.

25. That is, providing farmers and growers with an overkill of extremely complex and alien *researcher defined* parameters makes little sense.

26. Before the introduction of TVPC it was already calculated that the inclusion of a greater variety of production graphs would double the selling price (to fl. 1,000.- instead of fl. 500.-); an ex-post adaptation of the package in this direction would certainly have greater financial consequences.

27. It seems that the largest enterprises have the most positive expectations in relation to INFOTUIN/TVPC and TELETUIN. The average enterprise size of those who are certain to participate is 1.32 ha., versus 1.04 ha. of those that are still in doubt and 0.83 ha. of those who indicate that they will not participate ($F = 2.54$; $p = 0.105$). The latter category seems to be slightly older than the others as well; on average they are 44 years of age, while the average age in the other categories is 40 respectively 41 years of age ($F = 0.48$; $p = 0.62$).

28. Doing so would not have been consistent with the impartial position that the researcher was trying to take. Also, it would probably have jeopardized the good relations of the researcher with SITU/NTS and DACOM, and therefore endangered continuation of research activities.

29. Similarly, for users such requirements are supposedly relatively low for strategies 2, 3 and 4, and relatively high for strategy 1 (Davis & Olson, 1985:492).

30. The concept of enrolment is derived from the 'Sociology of Translation' (Latour 1986; Callon 1986a) and seems quite suited to describe what was going on (see also section 6.3). It must be noted, however, that in this case-study the term is used somewhat differently than in e.g. the case-study of Callon (1986a). Callon looks at the enrolment process as a technique to gain 'power'. Because he only looks at the process from the perspective of one particular actor, he fails to show the balance of powers that is in fact implied by it.

31. Many Dutch universities have such a 'Science Shop'. Science Shop-like institutions have been established from the seventies onwards (Depla, 1987:3), and are aimed at providing less-endowed organizations with relevant scientific insights. This means amongst others that such organizations can - through appointed intermediators- access university funds for carrying out scientific research. If successful, applications of less-endowed organizations result in a research process in which university staff, clients and intermediators cooperate closely. The Science Shop at Wageningen Agricultural University, for example, has developed extensive guidelines and procedures for selecting appropriate research questions, facilitating cooperation between the parties involved, etc. (Wetenschapswinkel, 1988).

In some ways, my case-study resembles such Science Shop-studies (i.e. a less-endowed client, political nature, a client-defined practical problem statement), but in others it does not (i.e. the study was conducted at the initiative of the researcher, the researcher had his own theoretical and methodological agenda, no formal supervision committee existed, no intermediators were involved).

Chapter 10

Planned technology development and local initiative
(case-study 3)

In this chapter, I will try to reconstruct the development histories of both INFOTUIN/TVPC and TELETUIN. First, I will outline in section 10.1 why I have continued my explorations in relation to these 'automated' ERCS in this manner, and elaborate on the methodology adopted in doing so. In the sections 10.2, 10.3 and 10.4, I will discuss the development histories of INFOTUIN, TVPC and TELETUIN respectively. In the last two sections of this chapter, I will outline the theoretical and practical implications of the study. I will argue in section 10.5, that CT-development processes are complex arenas of negotiation and enrolment in which actors attempt to create longer term outcomes or structural properties, and often have to deal with unintended consequences of their own and other actors' previous actions. Furthermore, I will suggest that such processes can be looked at as inherently social processes of learning. Also, I will point to the limitations of soft systems methodologies for facilitating such processes, and make plausible that the use of planned approaches towards CT-development may at times obstruct rather than stimulate the development of an appropriate innovation. Finally, I set out to develop a 'learning-oriented' method for CT-development which incorporates methods that originate from actor-oriented sociology, extension science and prototyping approaches (section 10.6).

10.1 Case-study selection and methodology

Selection of the case

There are several reasons why I found it interesting to analyze the development histories of INFOTUIN/TVPC and TELETUIN. Most importantly I feel that it is not sufficient to know *that* and *which* anticipation problems may exist, but also *how* and *why* they have come about (see section 3.2 for elaboration). That is, my theoretical framework urges us to understand the different characteristics, and the prospects for use and success which are associated with INFOTUIN/TVPC and TELETUIN, in their relevant time and space contexts. More concretely such historical understanding seems necessary for further improving our insight in relation to three related topics, which were not satisfactorily answered in chapters 8 and 9.

First, I would like to explore the prospects for user-participation in processes of CT-development, and the institutional conditions under which such participation may be effective (practical contribution 5). This case-study seemed particularly suitable for gaining such understanding since it appeared that horticulturists had played a major initiating role in both INFOTUIN/TVPC and TELETUIN, and had actively participated in the respective development processes, whereby SITU/NTS and DACOM constituted very different institutional settings in which these activities were embedded. Second, I felt that a study of actual CT-development processes could help to clarify further at what point contributions of social scientists (e.g. in the form of the type of user-research reported about in chapter 9) could be integrated in CT-development methods and procedures (practical contribution 5). Finally, since it had already emerged in my previous elaborations that an extension worker had played an important role in the development of TELETUIN, I expected this case-study to yield additional insights with respect to how extension workers can contribute to the development of appropriate CT (practical contribution 3).

Case-study methodology and sources

In order to obtain access to relevant actors and documents for this case-study, it was crucial to secure the cooperation of the various institutions involved, i.e. SITU/NTS (and particularly NTS), DACOM and the northern cucumber study club. While cooperation of the latter two was secured by means of two telephone conversations, the NTS board made their cooperation dependent on a decision by the National Committee for Enterprise Comparison (Landelijke Commissie Bedrijfsvergelijking, LCB). Hence, a research proposal was submitted to the LCB in which the most important conclusions of the previous study as well as newly emerging research questions were outlined, and in which it was stressed that the study might generate insights with respect to: (a) the different ways in which a CT could be developed; (b) the pros and cons of the respective procedures; (c) recommendations with respect to how future CT-development procedures should take place; and (d) recommendations with respect to realizing flexible and 'tailor-made' ERCS.

On the basis of this proposal, the LCB reacted positively to the request for cooperation. After orientating discussions with DACOM and NTS staff, several key actors were selected for in-depth interviews. In relation to both INFOTUIN/TVPC and TELETUIN seven such interviews (plus numerous additional telephone conversations) were held with five key persons. In relation to INFOTUIN/TVPC, these key actors included a NTS staff member (Gerrit West), a SITU staff member (Han de Wit), a regional study club supervisor (Annet Janssen) and two growers (Leen Jacobse and Jasper Wouters) (Unless indicated otherwise, all personal names in this chapter, including the above, are pseudonyms). In order to reconstruct the TELETUIN development history, interviews were held with Dirk Noorderling (i.e. the one person who constituted DACOM at the time), an extension worker (Karel Venneman) and three growers (Henk Adema, Pieter Harmsen and Jos van Es).

Although the interviews were explicitly prepared for and directed at particular actors, all of them included similar themes, such as: (a) the chronology of events in the development procedure; (b) the contributions of the different actors therein; (c) the aims, assumptions and interests connected with the different CT-development procedures; (d) the choices which were made with respect to the contents of INFOTUIN/TVPC and TELETUIN; and (e) the target-categories to which these 'automated' ERCS were directed.

Clearly, at some points the various participants in the development processes gave different representations and explanations of why, how and what had happened. In this chapter, I will refer to these (mostly non-accidentally) diverging evaluations when I feel that they are crucial for understanding the development process and its outcomes. I will thereby abstain from making value judgements and/or establishing 'the truth'. Furthermore, there are methodological problems involved in retrospectively interviewing people about their practices and actions of a few years ago; indeed actors may rationalize about these in a manner different from how they did at the time. Nevertheless, such ex-post evaluations are informative in themselves, but we must be careful not confuse them with actors' reflections at the time.

The reconstructions presented in the next sections are, even if they include the perspectives of different actors, biased. First, I was interested in particular themes which stem from my practical interests (see above); if I had been interested in, for example, the (financial) management of projects I would probably have ended up with a different reconstruction altogether. Second, I have selected only a limited number of actors who -on the basis of initial discussions with NTS and DACOM personnel- seemed to have been most actively involved. Hence, the perspectives presented are the perspectives of insiders, rather than those of actors who were involved at a distance.

In my effort to reconstruct the development histories of the two 'automated' ERCS, I also had access to a considerable amount of documents (minutes, project proposals, functional designs, manuals, etc.) and one 1990 demonstration version in relation to INFOTUIN/TVPC, while in the case of TELETUIN I could make use of three successive versions of TELETUIN (1988, 1989 and 1991) (little or no documentation exists in relation to the TELETUIN development process). In addition to being a form of direct empirical evidence, both documents and demonstration versions were used for the preparation of qualitative interviews. The research activities took place between October 1990 and March 1991. I am deeply indebted to Marlèn Arkesteyn (no pseudonym) who acted as my research assistant during this period. In fact, she has conducted most of the interviews, and helped me to structure and interpret the material collected.

10.2 The development history of INFOTUIN

In the following sections, I will discuss the various development histories under consideration. In the cases of TVPC and TELETUIN, I feel that it is possible to discuss chronological and thematic issues more or less simultaneously. However, due to the relatively large number of institutional changes that characterize the development of INFOTUIN, I have chosen to pay more explicit attention to the chronology of events.

1985 and 1986: Existing initiatives and the emergence of SITU as an 'obligatory passage point'[1]

In 1985, three Westland study clubs and three Westland auctions formally joined their postal enterprise registration and comparison initiatives, and started a central ERCS. In this context, the Committee Automation Enterprise Comparison (Commissie Automatisering Bedrijfsvergelijking, CAB) was established in August 1985 as a regional NTS committee with a mandate to coordinate the efforts to bring the existing initiatives together, and at the same time search for opportunities to automate enterprise registration and comparison activities (CAB, 1986). Several interviewees indicated that in the beginning CAB effectively consisted of two Westland tomato growers (I will refer to them as Leen Jacobse and Douwe

Feenstra) and an auction representative (who was employed as study club supervisor, whom I call Annet Janssen).

According to Leen Jacobse (who is referred to by all interviewees as a major initiator of both the central postal ERCS and INFOTUIN) it was already clear at this stage that an 'automated' ERCS would have to include the following characteristics: (a) on-line data entry in order to prevent mistakes; (b) regional controllers for each study club whose responsibilities would include correcting faulty material and composing excursion-groups; (c) automated sanctions for those who violate discipline; (d) minimal hardware requirements (i.e. what were at the time labelled 'home computers' instead of the more advanced 'personal computers'); (e) it should help to save time; and (f) all fruit-vegetable growers should be able to participate.

At that point in time the horticultural auctions had already been heavily involved in the implementation of the various postal ERCS for years. From their perspective, an 'automated' ERCS had the potential to reduce costs for postage, data entry and control considerably. Hence, in order to raise money for its initiatives, CAB approached a board member of the Central Bureau of Horticultural Auctions (Centraal Bureau Tuinbouwveilingen, CBT), who - due to his earlier involvement with the Database for Horticulture and Trade (Databank Tuinbouw en Handel, DTH)- had a lot of experience with viditel and videotex. About this CBT board member Leen Jacobse argued:

> "Like any other person he felt a need to realize his ideas, and show that they weren't all that crazy. In fact, we have brought two pieces together. They had the technology and the know-how, and we had knowledge concerning enterprise comparisons, and wanted to automate it. Thus, we have found each other quickly. A handful of money (...) and that resulted in INFOTUIN."

Indeed, in 1986 CBT granted a subsidy of fl. 50,000.- to CAB, of which Leen Jacobse maintained that it had earlier been promised to SITU (see later on), but which CBT was reluctant to pay because they were afraid that it would be spent on bureaucracy. Subsequently, an experimental videotex application was developed within three months, for which CBT and DTH had brought in equipment, programming knowledge and experience. The contents of this first 'automated' ERCS were decided upon by CAB, and were based on the then existing central postal ERCS.

> "The contents were taken care of by Leen Jacobse, Douwe Feenstra, Han de Wit [SITU] and me, (...) but it is all based on what was already being done at the auctions." (Annet Janssen)

At a later stage (and following DTH staff suggestions), CAB contacted a private software firm (named INTERMATION) in order to negotiate the possibility that the latter's computer would serve as the central videotex database. Indeed, CAB and INTERMATION reached an agreement and a one-year contract was signed. Annet Janssen described the role of INTERMATION as limited at this stage:

> "The task of INTERMATION was relatively brief; the information analyses had already been carried out. INTERMATION only had to modify the whole thing in order to make it suitable for their computer."

In order to quickly get the experiment off the ground, but in violation of the conditions of CBT[2], the fl. 50,000.- were mainly spent on simple computer equipment (MSX-computers, modems and printers) for members of a tomato excursion-group and members of a pepper excursion-group (in total seventeen growers).

It seems that in the process of all this, the organizational structure of CAB was considerably extended and formalized. Towards the end of 1986, CAB consisted of the central committee, four working-groups and one sub-group, involving 56 positions which were distributed over 26 persons (CAB, 1986). These persons involved growers and study club representatives (11), extension workers (2), representatives of research institutes (LEI/PTOG) (3), SITU staff (2), auction representatives and study club supervisors (4), programmers and technical advisors (3), and a study club secretary (1). Thereby Leen Jacobse, Douwe Feenstra and Annet Janssen -who largely constituted CAB in 1985- were (amongst others) involved in the Working Group New Developments, together with SITU, PTOG, LEI, DTH and auction staff. The research institutes were involved since it was included in the project that these would carry out statistical analyses on growers' registration material, and thus support the drawing of general conclusions.

A new actor on the scene

In section 7.1, I have shown that government subsidies were available for the creation of branch-specific organizations which would have a task in coordinating CT-development activities, and distributing INSP-LV funds. Hence, the NTS had -together with several other organizations[3]- initiated the establishment of a horticultural branch organization called SITU earlier in 1985. However, not all actors involved in initiating both the central postal ERCS and CAB were happy with this development. Some growers especially -at least in retrospect- felt that SITU was imposed on them in an illegitimate manner, and that the organizations posed a threat to their own initiatives and influence. Thus, Leen Jacobse was still very critical and apparently felt in 1990 that his (and other growers') role in the establishment of INFOTUIN was insufficiently recognized:

> "The SITU has water on the brain; it is an extremely bureaucratic organization that the growers have never asked for, but that they still pay for, since SITU gets a few percent of the Landbouwschap levy. That the SITU was erected by NTS was without consultation of the growers. We only found out later from documents (...). Well, then the shit really hit the fan. You see, they needed money for the enterprise comparisons, so probably a few people within NTS decided to erect SITU.
>
> The problem was that SITU wanted more or less to establish independently an enterprise comparison system, outside the existing initiatives. The growers weren't happy with this at all, especially since SITU did not have a clue about enterprise comparison and the things that growers are occupied with.
>
> The SITU was erected in February 1985 but the first year they were having an identity crisis so they were not involved in matters of content. (...) In the beginning of 1986, Han de Wit [SITU] started to slowly walk with us. Again, this was a man who had been catapulted to project supervisor by NTS, but the man knew nothing. The Westland had not asked for this. You see, of course such a man is in a difficult position: he is placed somewhere just like that, but those that he is supposed to work for don't want to know him.
>
> You have to look at it this way: We in the Westland had already started with our program when the SITU started finally to get its act together. But of course there were groups outside the Westland who wanted to do something with enterprise comparison as well. Thus, two things were

going on: We were working on a program and SITU wanted to establish a *national* project. You will see that such regions like Limburg and De Kring were in contact with SITU from the outset. For them enterprise comparison was connected with SITU. But in fact the program is ours. (...) The SITU gave the program its present name INFOTUIN, but that is the only thing they did."

While Leen Jacobse continuously down-played the contribution of SITU to the development of INFOTUIN, I have already shown that Annet Janssen includes Han de Wit of SITU among those who were involved in determining the contents of the first experimental program. Han de Wit himself also underlined his early involvement:

"Yes, I was already involved with that. But that first experiment was indeed carried out with the money of CBT."

On closer questioning he added:

"Well, maybe there were a few weeks between the first steps of INFOTUIN and the involvement of SITU, but it couldn't have been many. (...) The NTS did not have the technical know-how, so SITU picked it up. The task of SITU was to participate in the pilot project (...) and lift the enterprise comparison program to a more national level. This was inherent to the INSP-subsidy. SITU had a national character anyway, and the subsidies were nationally aimed as well."

1987 and 1988: Consolidation, stagnation and controversies

Despite Leen Jacobse's retrospective criticisms towards SITU, he was at the time also aware that SITU involvement -and thereby a national character of the project- needed to be accepted in order to get additional INSP-LV funds for the project. In the beginning of 1987, Leen Jacobse even played an active role in getting SITU's project proposal accepted by the Ministry after earlier versions had been rejected. As Leen Jacobse himself described:

"I told the director of SITU that I would rewrite the application for him. (...) This man doesn't know the ins and outs of enterprise comparisons, and he has therefore submitted my version to the Ministry."

In this SITU proposal, the fl. 50,000.- from CBT was referred to as 'advance funding' for the SITU project (SITU, 1987:6). Similarly, the time investments of the study clubs and grower participants were included in the budget as well, which was explained by Leen Jacobse with reference to an earlier experience:

"Why would some external advisor receive a fat salary for writing down what we told him, while we get nothing? Is his advice somehow superior to ours? We decided that while the money was available, we might as well make sure that the study clubs were rewarded for their efforts."

Leen Jacobse went on to explain how he "drove to the Ministry" and contacted a "big shot" - a man he knew since they used his enterprise to show foreign VIP's around- in order to arrange approval. A subsidy of fl. 533,440.- was granted in June 1987 (MLV, 1987b) and - as Leen Jacobse insists as a reward for his intervention- SITU subsequently agreed to build on the software that CAB had already developed.

Following the approval of the SITU-project proposal[4], CAB established the Foundation New Developments Horticulture (Stichting Nieuwe Ontwikkelingen Tuinbouw, SNOT) which was -in the context of the expected subsidies- supposed to deal with the financial matters around the development of the 'automated' ERCS in the Westland. The board of this foundation was formed by the treasurers of the three Westland study clubs and a CAB representative. Similarly, SITU took over the copyright of INFOTUIN.

INFOTUIN, at this point, fitted into the SITU/NTS policy, which was that, for privacy, compatibility and research reasons, one -SITU/NTS controlled- national 'automated' ERCS was to be developed for all horticulturists. From 'all horticulturists' in this respect, it followed that the package should neither be expensive to use, nor complicated. The active involvement of both organizations in the development and distribution of software, however, conflicted with agreements made earlier with private software firms (united in DICOTU[5]). Yet, SITU and NTS legitimated their activities by pointing to the fact that, despite repeated requests of growers, these organizations showed no interest in responding to the growers' needs in this respect.

In 1987, the program was extended to cater for crops other than tomatoes and peppers, and to provide not only crop-technical variables but also data on labour input and production. All participants in this process emphasized again that there was little discussion about substantive matters, since INFOTUIN was merely an automated copy of the existing postal systems. Similarly, the 1986 program was modified in order to allow for participation of a larger number of growers. In 1987, 90 growers participated, and in 1988 this number had grown to 300. Similar phenomena as described in chapter 9 also played a role:

> "The group of growers who wanted to use videotex increased enormously, especially among tomato growers. That was because one of the leading figures in tomato growing had videotex, and other growers wanted to be in his excursion-group."

These 300 growers represent some 30 percent of the fruit-vegetable growers who were involved in enterprise registration and comparison. In total it was estimated that, in 1988, 1,000 growers participated in the comparison of production parameters (300 by means of INFOTUIN); 450 of these compared climate and fertilization parameters as well (300 by means of INFOTUIN), while 90 compared labour parameters (50 by means of INFOTUIN) (SITU, 1989). The large majority of these growers were tomato, cucumber and pepper producers with heated glasshouses, of which there were some 2,800 (1,586, 789 and 436 respectively) in 1988 (LEI/CBS, 1989). Similarly, at this stage the large majority of participants in INFOTUIN were members of one of the three Westland glasshouse-vegetable study clubs, which had about 1,500 members in 1987 (SITU, 1987).

The central videotex database remained on INTERMATION's host computer, and in the course of 1987 SITU signed a three-year contract with this organization. It was decided that the property rights of the software belonged to INTERMATION, while SITU/NTS had the exclusive rights of usufruct. In 1990, Leen Jacobse argued that this was an unfortunate mistake:

> "This was a very stupid thing to do, because they are still stuck with them. (...) For INTERMATION the whole thing was rather unusual, since normally they are the ones who develop the program; in those cases they make adaptations free of charge. In our case it didn't work like

> that since CAB had made the whole design. In fact, we were basically renting INTERMATION's computer. With that contract they [SITU/NTS] really cut the ground from under them since a fat bill had to be paid for all adaptations."

Another organizational development was that regional INFOTUIN controllers were appointed (paid by the auctions but working for study clubs), which served as an intermediary between SITU and the growers. Furthermore, since INFOTUIN had become a national project, the national pendant of CAB, namely the National Committee for Enterprise Comparison (Landelijke Commissie Bedrijfsvergelijking, LCB), became increasingly involved in discussions concerning INFOTUIN as well, even if the 1987 changes were still decided upon by CAB. Similarly, the NTS established the Foundation Exploitation Information Processing for the NTS (Stichting Exploitatie Informatieverwerking voor de NTS, SEIN) as the national pendant of SNOT.

Institutional and financial confusion and irritation
Hence, in the course of 1988 there were a number of institutions involved with INFOTUIN (NTS, SITU, CAB, CAB working groups, SNOT, LCB, SEIN, CBT, DTH, Regional Controllers Platform, INTERMATION, LEI, PTOG and various regional study clubs and auctions). This caused considerable confusion, and both CAB and NTS published internal documents in which it was tried to clarify the situation. The introduction of the NTS document (NTS, 1988) said:

> "A few years ago, a start was made among glasshouse-vegetable growers to compare data concerning cultivation, labour and production. In order to stimulate and coordinate this, several bodies that could contribute to enterprise comparison have been established. The consequence was that at a certain moment in time it became unclear which tasks were to be carried out by which committee (foundation), so that committees started to execute tasks that they had not been called upon to do. This has led to an organization in which several bottlenecks occur, especially in relation to policy issues. From this the execution of concrete tasks has suffered." (NTS, 1988:1)

Similarly, the CAB document concluded:

> "We can conclude that quite a number of organizations, (working) groups and committees are actively involved with enterprise comparison in the Westland. There is a lot of obscurity about how the whole thing works. (...) That indistinctness is caused especially by the fact that many information lines cut across the official structure." (CAB, 1988:8)

These documents emerged in the context of increasing irritations and conflicts among the institutions involved. In this process several participants lost confidence in SITU. For the researchers it was impossible to reconstruct exactly everything that happened since most interviewees were reluctant to speak about it. It is clear, however, that there were both substantive and financial problems, whereby matters of mandate, responsibility and authority played a role as well. In earlier quoted NTS document some bottlenecks were highlighted:

> "Nationally speaking the main bottlenecks are in the line section board/LCB/SEIN/region. (...) SITU-NTS, for example, arranged the access number for INTERMATION. At a certain moment, the auction wanted their own access numbers. SITU was present in the discussions about that, but when the deals had been made, the NTS was left uninformed about the agreements made."

"Hereby it becomes also clear that the position of SITU in this whole is a question mark. SITU has interfered too much on issues that -substantially speaking- they should have left alone. This has historically grown, for SITU got a free mandate from NTS. At a certain point, it became impossible to steer. SITU should have been only responsible for requests for subsidies from the government, and for taking care of coordination between the different branches of agriculture and horticulture."

"Growers got the impression that the enterprise-comparison project was a project of SITU. This appeared not to be the case. The growers lost confidence in the SITU, and the consequence of that was that no growers were available for functions in the SITU board" (NTS, 1988:7-8).

"In the past, SITU has pulled the videotex project too much towards itself. Instead of coordinating, they paid too much attention to matters of content. The SITU was supposed to function above the different crops, and not within the crops. From discussions it emerged that SITU is too slow with passing on information. It looks like a state-bureaucratic institution. The finances are never clear, and the foundation is at too large a distance from the growers." (NTS, 1988:5)

"What did not help the situation either was the fact that the Westland -in order to stimulate the development at national level- was slowed down by the NTS in the development of the enterprise-comparison project." (NTS, 1988:7)

Other problems identified in the document referred to several weaknesses of the LCB, and the lack of contact between this committee and others, e.g. the regional controllers. It seems that growers especially did not accept the level of involvement of SITU with respect to the exploitation and development of the 'automated' ERCS. Although in the documents, SITU's involvement in 'matters of content' is frequently criticised, I have shown so far that -in terms of the parameters included in it- decisions with respect to the contents of INFOTUIN were taken quite harmoniously. However, from the quotes above one gets the impression that conflicts centred especially around how INFOTUIN had to be organizationally embedded, and around the pace in which INFOTUIN could be further adapted and expanded for those that were already using it. This interpretation is supported by the fact that seven cucumber growers from Drenthe discontinued their participation because they did not find it flexible enough, and changed over to TELETUIN (see section 10.4).

It seems that growers' pressures caused a (real or perhaps partly orchestrated) estrangement between SITU and NTS. As a consequence, it was agreed that NTS (and its committees LCB and SEIN) would formally take over the exploitation and responsibility for INFOTUIN from 1-1-1989 onwards, while SITU remained the contact for the Ministry and INSP. Han de Wit spoke about this episode in a somewhat 'legalistic' manner:

"We, as SITU, have the task to initiate, coordinate and stimulate automation projects. But when the project is taking off, our job is more or less finished. The supervision of study clubs and building an infrastructure, of course, is not a SITU task. The system has proved itself, so it could be transferred to NTS."

Gerrit West (NTS) explicitly urged the researchers to leave the issue alone:

"There are a few old cows with respect to the transfer from SITU to NTS, but let bygones be bygones. There were different opinions with respect to where enterprise comparison belonged."

There are indications that the developments at this point need to be looked at in the context of financial controversies as well. From a document (dated November 1988) of one of the Westland study clubs which participated in CAB (Tuinbouwstudieclub Westland-Zuid, 1988), it becomes clear that throughout 1987 and 1988 there have been various financial conflicts and peculiarities, which came to the surface in the context of the transfer of INFOTUIN to NTS. Without going into too much detail, these included the following:

(a) Between 1986 and 1989, CBT had promised to pay in total fl. 210,000.- to SITU, under the condition that individual auctions would pay part of this. The individual auctions never paid, and -with the consent of the three study club boards- proposed to 'pay' with man-hours that had already been spent on the project, but were not included in the SITU-project. Despite these controversies the SITU, NTS and CAB went on with the project as planned.

(b) Vegetable growers came to the conclusion that the financial constructions boiled down to the fact that vegetable growers were -through their cooperative auctions- indirectly paying for developments that other growers (e.g. flower growers) were benefiting from as well.

(c) In 1988, the LCB proposed a number of changes in INFOTUIN. The costs for these changes were within the budget limits, but CBT responded to SEIN that no money would be supplied before the financial matters were straightened out. Subsequently, SEIN claimed that SNOT had illegitimately received more than fl. 21,000.- which now needed to be transferred to SEIN. According to Leen Jacobse this fl. 21,000.- represents the INSP-LV subsidy on the fl. 50,000.- which was donated by CBT to CAB, but which was also included in the budget of the SITU project. The chairpersons of the three Westland study clubs agreed to remunerate SEIN's claim, but under the condition that the whole affair would be thoroughly investigated.

Taken together, these matters resulted in both further distrust towards SITU and a major crisis within the three Westland study clubs and CAB towards the end of 1988. Leen Jacobse (who is the only respondent who wished to speak about this episode) gave the following account of what happened, and added another dimension to these opaque financial manoeuvres.

> "Apart from the initial fl. 50,000.- from CBT, we [CAB] unexpectedly received an additional fl. 80,000.- for the Westland project from INSP-LV. You see, that was the money that had been budgeted for our own efforts, but we never expected that we would get it just like that; we don't usually count on subsidies. (...) Anyway, we had to quickly establish SNOT in order to receive that money in a decent way. But of course the project was already on its feet when that money came in because of the fl. 50,000.- from CBT. So we asked the people whether they wanted to have the money, but everybody decided to donate it to SNOT and save it for the next update of INFOTUIN.
>
> However, when the money came, the NTS and SITU wanted to have it for the national project. (...) We also wanted to extend the project to a national level, but we didn't want to spend the money on talk and paperwork; we didn't want to throw it into the bureaucracy because if you do that fl. 80,000.- is very little. We looked at it as risk capital. (...)
>
> The people who had initiated the whole thing and had a vision were then faced with the criticism by the national NTS that they were working for themselves. We had spent an enormous amount of time on this project, hundreds of hours per year, without personal interests, and then you get that sort of criticism. The whole meeting circuit started to poke their nose into it and talk about whether we had done right or wrong. (...) We got a letter from the Westland study clubs in

> which we [the three initiators] were thanked for our efforts, but which also said that they didn't want to make use of our services any longer. (...)
> When they first said that we had been working in favour of our own personal interest, we immediately decided to leave CAB and the study clubs; we didn't await all the talking. We decided that the project was already pretty mature, so that it wouldn't disappear without us anyway."

In section 10.3, I will show that after the crisis in the Westland study clubs, grower participation in the further development of the 'automated' ERCS shifted from the Westland region to the neighbouring area De Kring.

1989: INFOTUIN goes national and faces competition

During 1989 -and in response to earlier pressures from study clubs in other regions- efforts were made to get INFOTUIN more widely adopted outside the Westland. Indeed, the 'automated' ERCS was adopted by excursion-groups in De Kring, Barendrecht, Utrecht and by tomato growers in Brabant/Limburg. Hence, the number of participants increases to 423 (and 625 in 1990). In the course of 1989, NTS became under increasing pressure from growers (amongst others the Stoke-Cucumber Study Club Brabant/Limburg, see section 9.7) to add graphical facilities to INFOTUIN, similar to those already present in TELETUIN. Thus, the newly established Technical Working Group (Technische Werkgroep, TWG) of the LCB starts to work on facilities for making comparisons between different years, allowing variable growing seasons for each enterprise, and providing INFOTUIN with a free page and a processing module (see section 10.3).
At this stage the cooperation with INTERMATION had become increasingly formalized, which is reflected in the use of formal CT-development methodologies (see section 7.4) as well.

> "I think it is a good thing that it becomes more and more formal. Not only for us but also for INTERMATION. In the beginning we had a good contact person within INTERMATION, so it all went pretty well. (...) If there were agreements at all, it was always like: "Well, things will be all right". But nobody really knew what to expect. It is good to record things formally. It makes it all much more clear, and it means that we really have to think clearly about what we want. And consequently they are more tied to fixed agreements as well." (Han de Wit)

A significant development in 1989 was that INTERMATION changed to a new programming language (to Cobol-85 instead of Cobol-74), which meant that it became more complex and expensive to make adaptations. In August 1989, INTERMATION (on request of SITU) delivered a document which described the functional specifications of the required adaptations (INTERMATION, 1989). Also a quotation was provided in relation to both these adaptations and a conversion of INFOTUIN from Cobol-74 to Cobol-85. According to Gerrit West (NTS) both adaptations and conversions appeared far too expensive. In September 1989, however, INTERMATION was asked to make a limited adaptation to INFOTUIN, i.e. to provide it with a free page.

The costs made during the first phase of the project (i.e. until 1-1-1989) amount to almost fl. 500,000.-[6] of which 54 percent was paid by the Ministry, while 46 percent was invested by the other participants (NTS, auctions, study clubs, etc.). For the second phase of the project (the 1989 and 1990 period), SITU estimated the total costs at approximately fl. 568,000.-, of which the Ministry was requested to pay about 50 percent. According to the SITU proposal, about fl. 200,000.- was required for project management, while the rest was reserved primarily for the development of new software and the adaptation of existing software (increasing standardization and compatibility with other software, providing facilities for file-transfer, making the software fit for more users, enlarging the number of parameters included, etc.) (SITU, 1989). In this project proposal (dated February 1989), the development of a processing module was not explicitly mentioned; nevertheless, the development process of TVPC started in March 1989.

10.3 The development history of TVPC

The actual development of TVPC took place between March 1989 and August 1989. Since this is a relatively brief period, I will discuss its development in a more thematic manner than was the case with INFOTUIN.

The channelling of new local initiatives

In the course of 1988 -i.e. when the prices for personal computers were already dramatically lower than at the start of the project in 1985- the Working Group Automation Enterprise Comparison (Werkgroep Automatisering Bedrijfsvergelijking, WAB) in De Kring (a region neighbouring the Westland) started to develop ideas about off-line processing of INFOTUIN material on PC, amongst others, in the form of graphs.

> "With INFOTUIN we could never get a clear long-term overview. That is why we thought it would be handy to continue with graphs." (WAB-grower 1)

While developing these ideas, a grower of WAB (Jasper Wouters) contacted TELETUIN developer Dirk Noorderling (DACOM) who, on that occasion, provided the former with a demonstration version of TELETUIN. In retrospect, a grower participant in the TELETUIN development process made it clear that he felt that Dirk Noorderling was badly treated by WAB and NTS:

> "I mean, it is really suspect that TVPC emerged quite rapidly after Dirk Noorderling left the demonstration version in De Kring. Dirk Noorderling went to NTS full of trust and enthusiasm, and then that is what you get." (Henk Adema)

However, Jasper Wouters argued that there were good reasons not to make use of Dirk Noorderling's services. From his statement quoted below it becomes also clear that INFOTUIN was not only important to growers because of its enterprise registration and comparison functions, but also because of the auctions' service of providing daily accounts through INFOTUIN (see also section 7.2).

> "We have told Dirk Noorderling what we wanted, and asked him whether he could develop a program for us. Noorderling merely told us that he was not going to make a separate program for us and that we should join TELETUIN instead. The problem was that some of us were stuck with the central computer of INTERMATION, and INTERMATION was typing in the daily accounts

from the auction. We have asked Noorderling how he was going to solve the problem of the daily accounts. After all he was all alone then. You see, if you talk to Noorderling, he promises everything, and the program looks good indeed, but if you look at it more closely, it is amateur-like. (...)

I must say that people have chuckled here about Dirk Noorderling's thought that -if he received the auction accounts at 4.00 p.m.- he could have them in the computer by 4.30 p.m. (...) Noorderling completely underestimated the data entry. Similarly, on Sunday there is peak-use of the lines. Noorderling suggested that we should make agreements about who was going to call when. But the central computer has to adapt to us, and not us to the central computer. No, with Noorderling everything was possible if first we joined his program. That is not the way we work." (Jasper Wouters)

But Jasper Wouters also indicated there were more 'political' and financial reasons to choose for NTS as a partner in realizing their ideas:

"We wanted to prevent the enterprise comparisons from being cut into bits, and us losing the connection with other regions. (...) In fact, we already had an oven-ready recipe for TVPC. We had even asked for quotations for such a program at several firms. But it appeared too expensive. There wasn't that much money to be got from the study club. That is why we went to NTS."

This cooperation between NTS and WAB needs to be understood in the context of the vacuum in grower participation that emerged after the crisis in the Westland study clubs. Nevertheless, NTS appeared somewhat hesitant to remunerate WAB's proposal, not least since it was already envisaging a whole new set-up for enterprise comparisons, in which NTS would no longer have to violate its agreements with DICOTU regarding the development and exploitation of software.

"The NTS tried to slow the whole thing down because they did not want to irritate SEB[7] [a subset of DICOTU members; mainly developers of climate computers, fertilization computers, registration packages, etc.]. But we have told them that -if they would not join us- we would start for ourselves." (Jasper Wouters)

Gerrit West (NTS) also indicated that they were more or less forced to go along with WAB's proposals:

"Before TVPC was developed, there were already plans for that [a totally new system]. We knew already in advance that TVPC would be short-lived. Nevertheless, we decided to develop it since the growers called for it. If we wouldn't respond to it, they might start to mess about with it in a decentralized manner, which would not be a contribution to unity."

Other participants in the TVPC-development process explicitly denied that they were already anticipating that eventually INFOTUIN/TVPC would be replaced by a different system. Han de Wit (SITU) indicated that the ideas for a new system emerged at a much later stage, when they were already working on expanding TVPC:

"There was a demand for TVPC, so we started to work on it. We didn't know anything about a new program. Yes, at a certain point it became clear that INTERMATION changed to another operating system, so we knew that there would be difficulties if we wanted to make adaptations and so forth. Those adaptations were a technical problem, with major financial consequences. But the new system, no. That did play a role, however, when we were working on the processing modules for production and labour in 1990."

The institutional and procedural dimension

As I have shown in section 10.2, LCB established a Technical Working Group (TWG, sometimes referred to as Technical Committee as well) in 1989, which was amongst others supposed to direct the development of a processing module. The TWG consisted of two members who were also members of the Working Group New Developments of CAB (CAB's supervisor Annet Janssen and Han de Wit of SITU), Gerrit West (NTS), Jasper Wouters (a grower from De Kring and member of WAB) and Jeroen Asperen (a grower from the Westland). According to Gerrit West, the reasons for not including growers from other regions were mainly of a practical nature:

> "Distance plays a role. Every week there is a meeting of some sort, but such meetings last only one hour or one hour and a half. You cannot come all the way from Limburg for that. It is a practical consideration. In the other regions there were indeed ideas about TVPC, but they have been transferred to us via the LCB and the regional controllers."

For the development of TVPC, a much more formal and SDM-like procedure (see section 7.4) was adopted than was initially the case with INFOTUIN. On the basis of existing ideas and experiences (see later on) TWG designed a detailed functional plan in March 1989. This plan extensively described the specifications that the processing module would have to meet (NTS, 1989). It was sent to several commercial software firms in order to obtain quotations in the beginning of April. Similarly, and apparently in order to prevent future collisions, DICOTU was contacted as well, and asked to find out whether or not their members were interested to commercially develop and exploit such a processing module. Eventually, however, an independent software firm (TECHNOLUTION) got the order to build a processing module, while INTERMATION was asked to develop the necessary software for data exchange between INFOTUIN and this local processing module. Hence, DICOTU was again bypassed, and once more NTS became involved with the 'commercial' exploitation of software:

> "The DICOTU quotation wasn't in time, and thus the order was granted to TECHNOLUTION. They presented the only quotation that was rather realistic." (Gerrit West)

Although a formal quotation of DICOTU was never received, Han de Wit (SITU) indicated that -on the basis of discussions with members of DICOTU- it was concluded that purely commercial development was not a viable option, because the program would turn out to be too expensive for growers:

> "To have the program developed by DICOTU -that is, on a commercial basis- appeared to be too expensive. Our condition, namely, was that the costs of buying the program should not exceed 500 guilders. The DICOTU members weren't really ready for such a development too, but they still looked at NTS as a false competitor. According to them, NTS is not allowed to develop software."

With some minor adaptations, TECHNOLUTION implemented the detailed functional design made by TWG, and testing of TVPC took place in July 1989. Originally, the idea had been to use 30 different growers for testing, but as Gerrit West explained, such extensive testing did not materialize:

> " ... such a large testing group seemed ridiculous. If the starting point is that 100 packages should be sold, 30 tests is a very large number. How can you find 30 growers who would like to participate?"

Eventually, the program was tested by five persons (three of which are growers). However, as Jasper Wouters indicated, some of the growers involved others in their tests as well.

> "I myself have tried it on about five different growers' equipment; a BRINKMAN computer, a PRIVA and a TULIP. Jeroen Asperen has tested it on a HOOGENDOORN, and Han de Wit and Annet Janssen have tested it at several places as well. Thus, altogether there were quite a few tests."

From this and other quotes it becomes clear that the tests were primarily of a *technical* nature, i.e. the content of the package was not subject to evaluation.

> "The necessary adaptations were merely technical. There was an adaptation with respect to the OKI printer of HOOGENDOORN, and with BRINKMAN there was one wire short in the cables. But they have told us that they would provide everybody with a new cable for free. With the PHILIPS I think there was an adaptation that had something to do with the modem, and it didn't print well. Those problems were quickly overcome. The contents were well received. We had already told them that we wouldn't make adaptations in the contents anyway; they were supposed to save those up for the next year." (Jasper Wouters)

In August 1989, TVPC was released. Subsequently, the TWG continued to work on extending TVPC with facilities for the off-line input of labour parameters, and the processing of both production and free-page parameters. In relation to these latter two extensions, detailed functional designs were ready in May 1990 (NTS, 1990a, 1990b). As I will show later on, however, these were never implemented.

The contents: narrowing down to climate and fertilization parameters

In the original ideas of WAB, the processing module was supposed to become a package in which a wide variety of parameters (including production, climate, fertilization and labour) could be graphically represented. However, the estimated financial consequences of building such a comprehensive package were not acceptable to both WAB and NTS:

> "He [an ex staff-member of BRINKMAN who was called in by WAB as an advisor] warned us that we'd better start with something simple, and that a complete version of TVPC would be far too expensive. We, as WAB, had posed the condition that the price of TVPC should not exceed 500 guilders. That would certainly be the case if we included production and labour right away. (...) NTS too thought that fl. 1,500.- for production and cultivation was too much." (Jasper Wouters)

Hence, it was decided that the processing module was to focus on '*cultivation*' parameters, i.e. climate and fertilization parameters. Apart from the financial merits, both Jasper Wouters and Gerrit West indicated that they wanted to experiment with a limited version in order to see whether or not the idea was viable.

> "Of course there was the question whether or not growers would be able to learn how to work with it. That is why we worked with modules. We started with the cultivation comparison, and after that we were going to extend. But we were stopped while working on labour and production." (Jasper Wouters)

> "For the moment, TVPC is only directed at the processing of cultivation parameters because we had to look first whether or not it fulfilled a need." (Gerrit West)

No doubt, however, Gerrit West's earlier comment that -from the NTS perspective- TVPC was, from the outset, a package that had to suit the needs of growers temporarily (pending the emergence of a totally new system), has played a role in this respect as well.

The reasons for starting with cultivation parameters were mainly pragmatic; i.e. tomato, pepper, cucumber and eggplant growers registered and compared roughly the same climate and fertilization parameters, while their relevant production parameters tended to differ. Furthermore, Jasper Wouters had already considerable experience in making graphs by using a spreadsheet program, and in his view cultivation parameters are crucial:

> "Cultivation is the principal issue; that is what you want to make decisions about; that is what the whole thing centres around."

Several interviewees indicated that Jasper Wouters and his WAB have played a major role in making a selection of parameters which were to be graphically represented in TVPC. Jasper Wouters explained his relatively large personal influence in terms of the lack of experience that other growers had with making graphs:

> "The problem with automation in horticulture is that growers do not know what they want. You go and ask a grower what he wants to be represented graphically. He doesn't know! And if you ask *how* he wants to look at it [i.e. the way in which it is graphically represented] you get stuck. (...) At a certain moment we have made an inventory of what growers wanted. I went to a tomato evening in Bleiswijk, and I asked them: "What do you want in graphs?" Well, most of them really couldn't mention more than four parameters. (...) Also, we held a survey among tomato growers who were using INFOTUIN, and asked them what sort of extensions they wanted, and about the graphical representations. Then, you get answers like: "For me it is not so important." or "I think it is quite alright as it is." (...) At a certain point we showed a demo of TVPC, and then we got at least some ideas because they could see it. (...) At first sight, growers never know what they want, but if you continue to discuss something will always come to the surface. Of those things we have made an inventory, and that resulted in the eleven lines."

It seems that it was already taken for granted during the inventory that the focus would be on cultivation parameters, and that -at the most- one production parameter was to be included. In the documentation we found original survey forms which were addressed to (and filled up by) members of the National Meat-Tomato Committee NTS (Landelijke Vleestomatencommissie NTS). The survey was dated May 8 1989, and signed by Gerrit West. None of the interviewees (including Gerrit West) remembered this survey, or its outcomes. In the survey growers were asked to rank-order fifteen specified 'cultivation' parameters (eight climate and seven fertilization-parameters) and one unspecified production parameter according to their priority in terms of graphical representation. Although unspecified, and mentioned at the very bottom of the list of parameters, 'production' still ended up with an average rank-number (n=14) of 7.8 (with extremes on both sides).

Han de Wit indicated that indeed TELETUIN had been an important reference point for determining the contents of TVPC:

> "We have made an inventory of what is registered in TELETUIN, and we have incorporated that in our system."

When asked why cumulative production figures (which tend to be rather popular among cucumber growers in both Brabant/Limburg and Drenthe, and are included in both the southern postal ERCS and TELETUIN, see chapter 9) were apparently not considered for inclusion in TVPC, he seemed somewhat confused:

> "Ah, they are there, aren't they? Let's have a look. (...) Well, there must have been no need for them. But such things you have to ask Jasper Wouters since he has been working on the contents."

Jasper Wouters, in turn, refers mainly to technical reasons (which probably need to be understood in the context of his own private hardware configuration) for not including them. In doing so, he apparently cannot resist to discredit TELETUIN:

> "Yes, I know they have that in TELETUIN, but what is the use of it? Only if you have VGA you can make high-resolution graphs, and with other screens those graphs are useless. You can see the beginning and the end, but in the period in between you cannot see what the exact figures are. You have to look back for those in the numerical overviews. No really, it is nothing. TELETUIN look good at first sight, but at closer investigation nothing remains."

It must be noted, however, that in the 1990 functional design for the extension of TVPC, several cumulative production figures were included (NTS, 1990a:3).

The fact that TVPC -in contrast to TELETUIN- does not directly facilitate the inclusion of registration material from different years in one graph is explained with reference to priority considerations and personal convictions:

> "When we started with TVPC the need wasn't there since there were no data to compare with anyway. For cultivation that issue would only become relevant in 1990. Annet Janssen came up with the idea alright, but we thought it was a later priority. In 1990, it wasn't included because we were working on production. (...) If we would have continued with TVPC it would have been included at some point. Personally, however, I wouldn't put money on the table for it. I think it belongs in an enterprise registration system [as opposed to an enterprise comparison system]." (Jasper Wouters)

Changing coalitions and the ending of the further development and promotion of TVPC

In the course of 1990, the NTS ideas about developing a totally new ERCS started to become more concrete:

"We knew that the contract with INTERMATION was ending in 1991, and that we had to start thinking about something new two years in advance." (Gerrit West)

Gerrit West gave the impression that the reason for opting for a totally new system related mainly to the lack of flexibility in INFOTUIN/TVPC:

"We of NTS did not resolutely want a new system. It is the growers that increasingly have more needs. That is what we have learned. (...) There are a number of things that play a role. First, INTERMATION changed from Cobol-74 to Cobol-85. (...) We have thought about making conversions but that proved to be extremely expensive. (...) Besides week 48 was problematic. After week 48 everything was erased because we couldn't deal with different years. Adaptations were too expensive. Also crop-independence plays a role. Developing a program is a long process for which an enormous amount of capital is required. If every crop has to invent the wheel again, it takes a lot of time and costs a lot of money. So it makes sense to build one framework for all crops. Thereby, we find that -technically speaking- enterprise comparison through videotex is outdated. It is all possible with file transfer. If you consider that we have more than 600 participants, and you want to expand, you have to start thinking about attainability. You have to make a cost-benefit analysis." (Gerrit West)

Similarly, Gerrit West (and also Annet Janssen) explicitly indicated that they wished to start from the principle that -for the sake of having a national system, which can be used by a large variety of growers- those who wish to run fastest would have to wait for the masses:

"I think you can distinguish between three groups of growers: (a) those who want a simple input, and watch and compare results; (b) those that are primarily interested in enterprise registration; and (c) frontrunners, who wish to analyze more and more. You have to satisfy them all."

At the same time, however, it appeared that NTS had second thoughts about being involved in the commercial exploitation and distribution of software, and (thereby) breaking earlier agreements with DICOTU and SEB:

"I want to emphasize once more that NTS is a non-profit organization, and not a commercial one. We have made that mistake once, but never again. We ought not take over the role of software suppliers." (Gerrit West)

A first meeting between SEB and NTS took place in February 1990. During subsequent contacts, NTS reached an oral agreement with SEB that NTS would be responsible for the development of a central crop-independent database for enterprise registration and comparison, while the SEB would take care of the development of local processing modules. Together they were going to work on an interface and data dictionary that would make these systems compatible. While the SEB software was expected to be ready by the end of 1990, the central database should be finished towards the end of 1991, so that SEB could use 1991 for testing purposes.
According to Han de Wit (SITU), one of the reasons that NTS made a deal with SEB was that -in the context of existing initiatives of SEB- it was afraid to be left out of a national ERCS, since the file transfer technology adopted by SEB did not require a central database.

"You see the Chrysanthemum growers were already working with MEMOCOM [an electronic mailbox system operated by PTT] in cooperation with SEB. Now there is of course the threat that

SEB starts independently with the help of MEMOCOM. That means that NTS misses the bandwagon. Of course there may be disadvantages for the growers, but still, it is a real threat. NTS needs to deal with that."

Gerrit West partly confirmed this, and indicated that SEB (which included the main developers of climate computers, fertilization computers and registration packages) had a strong position with respect to future developments in enterprise registration and comparison:

"Enterprise comparison as such may not be profitable for them, but look what happens if it is connected with enterprise registration, climate computers, process computers, etc. Then it starts to become interesting for members of SEB, then you can make it profitable. (...) Yes, you are right, with MEMOCOM growers can do enterprise comparisons without a central system, but the central system remains necessary for research and analysis. With the central system you can look over the excursion-groups, and with MEMOCOM alone you cannot."

Han de Wit was not particularly happy about the deal between NTS and SEB. When asked (in December 1990) why an altogether new system needed to be developed he reacted:

"Well, that is a good question. I myself think that TVPC is a good system on which we could build in the future. (...) NTS wants one central model for all crops. That means one application for both flowers and vegetables. But I have my doubts. (...) Among vegetable growers there is resistance too. When the chrysanthemum growers, etc. have to join, it means far too much ballast for the vegetable growers, which they don't want. Flower growers work with several departments in the glasshouse, and that needs to be incorporated with the calculations. (...) I don't believe in a crop-independent system. In that respect there are differences between NTS and SITU.

The deliberations between NTS and SITU are problematic. We have discussed our responsibilities and tasks, but the disturbed relationship continues. (...) In fact, we are now stuck with the agreements that NTS made with SEB about the local systems. TVPC is no longer a functionality of SITU/NTS, but those agreements do indeed have consequences for SITU. (...) Those agreements with SEB are all quicksand that we don't know a lot about. Information is withdrawn from us, but sooner or later it will come to the surface."

When asked about the independent manner in which NTS has made decisions in this respect Gerrit West argued:

"Look, eventually we have agreed on a division of labour between NTS and SITU. NTS makes the policy decisions, like this one, and SITU does not have that task. If we take a decision, they have to leap into it. They are there for the automation projects."

While the negotiations between NTS and SEB were going on, the TWG continued to work on the further development of TVPC as normal. In May 1990, detailed functional designs were ready for extending TVPC with processing facilities for production and free-page parameters (NTS, 1990a, 1990b), while a similar design for the off-line input of labour parameters became available in June 1990 (NTS, 1990c). In December 1990, Jasper Wouters was still angry about the agreement between NTS and SEB:

"NTS went crazy in the head on behalf of SEB. SEB has never ever achieved anything; never! Why would they suddenly do so now?! NTS cannot make agreements with SEB, because SEB never keeps a promise."

Nevertheless, he did not want to continue with TVPC either; in fact, he envisaged a new system that can only be realistically achieved with the cooperation of the much despised SEB.

> "My ideas have gone much farther again. I want a completely automatic input of climate data. Instead of one average measurement per week per parameter, that means 96 measurements per parameter per day. (...) You need to get on with it. You cannot make an enterprise comparison program that works for ten years. (...) You should be happy if you can go ahead for three years, and must bring your [investment] decisions in line with that. That is the way it goes in horticulture."

In order to prepare the development of the new ERCS, new committees and groups were established, i.e. the National Committee Information Provision (Landelijke Commissie Informatievoorziening, LCI) and a Steering Group Information Provision (Stuurgroep Informatievoorziening). As part of LCI, the Project Group Enterprise Comparison for Glasshouse Vegetables (Projectgroup Bedrijfsvergelijking Glasgroente, PBG) was established, which would start with making an inventory of the existing enterprise comparison situation as at 1990. This project group met for the first time in June 1990, and consisted of Annet Janssen (project leader), Gerrit West (assistant project leader), Jasper Wouters and two other growers who had experience with databases and spreadsheet programs. From the beginning, it was decided that Han de Wit would take over the duties of Gerrit West from September 1990 onwards.

In July 1990, LCI decided -eleven months after its introduction- that TVPC would not be further developed, maintained and/or promoted. The sale of TVPC effectively stopped shortly after this; in total about 100 copies of TVPC were sold. In September 1990, Jasper Wouters resigned from PBG because he continued to feel unhappy about the deal with SEB:

> "Well, the Steering Group has decided about that. In a plea not to do so I have given so many counter arguments, and they had no response to that. They have never been able to make clear to me what the added value of the new system will be. I think they are simply unable to. Look, if I tell you that I have a new bicycle for you, and it turns out to be exactly the same bicycle that you already have, would you buy it? Of course not! You would be crazy. Well, they are crazy in the NTS, or else I must be crazy. (...) Anyway, since we couldn't come to an agreement any more, it was time for me to leave."

From here on I will leave the entanglements around the development of the successor of INFOTUIN/TVPC alone. Suffice it to say that GROEINET became operational in the course of 1992. In April 1993, there were about 1,100 subscribers (75% vegetable growers and 25% flower growers), of which the large majority were members of Westland study clubs (personal comment Gerrit West). However, in May 1993, both Leen Jacobse and Jasper Wouters were very critical about the new system. In line with the experiences of TELETUIN users (see section 9.7), they felt that communication with the central database was much too slow, due the fact that GROEINET was designed in such a way that it needed to make calculations, and spent considerable time on searching, while sending and retrieving registration material[8].

According to the quotations from TECHNOLUTION and INTERMATION (which were accepted by NTS), the costs for building TVPC and adapting INFOTUIN to allow for file transfer were fl. 26,000.- and fl. 14,000.- respectively. Similarly, the costs for developing a free page amounted to fl. 10,000.-, while the expenditure on project management activities in 1989 was fl. 45,400.- (SITU, 1990). Hence, the total costs made on INFOTUIN/TVPC in 1989 approached fl. 100,000.-, of which about 54 percent was again paid by the Ministry. The remaining INSP-LV subsidy for the second phase of the project (see section 10.2) was invested in the development of GROEINET.

10.4 The development history of TELETUIN

The development of TELETUIN has taken place in a far less formal and institutionalized manner than was the case with INFOTUIN and TVPC. Thereby, there has been considerable stability in terms of the actors involved in the development process of TELETUIN throughout the 1987-1990 period. In this process five actors have been of particular importance, i.e. Dirk Noorderling (part-time arable farmer and -in 1987- 'director' of the one-man firm DACOM), a public extension worker (Karel Venneman) and three cucumber growers. Successively, these growers were the chairperson of the cucumber study club in Drenthe (Henk Adema), a grower who has been primarily involved in testing (Pieter Harmsen) and another ex-INFOTUIN participant (Jos van Es). Together with the three excursion-group leaders, these actors (with the exception of Pieter Harmsen) became -at the initiative of the extension worker- labelled the 'TELETUIN committee', which has met three or four times a year from 1988 onwards.

The conception of TELETUIN: an isolated region swims against the tide

In the period before 1986, enterprise comparisons in Drenthe took place in a rather informal manner. Some growers were unhappy with this, so that six of them became early INFOTUIN participants in 1986 (and were joined by a seventh in 1987):

> "There were some manual enterprise comparisons among growers, but there was little organization. We exchanged some data concerning costs, gas use, labour and production, but there was not enough commitment; you basically did it for yourself. It wasn't structured on forms etcetera. However, there was the production comparison, which was organized by the auction. (...) That is why we changed over to the computer; in order to make it a bit more structured. You know how things go; the weekly excursions became more cosy every week, but the learning decreased." (Henk Adema)

However, pretty soon both the cucumber growers and the extension worker became frustrated with INFOTUIN, primarily because of its inflexibility:

> "We wanted to include more data concerning crop-protection, fertilization, watering. In the beginning INFOTUIN only included programmed climate, and we wanted realized climate as well." (Karel Venneman)

Despite repeated requests to NTS and SITU, it appeared that they were not ready and/or able to respond to the growers wishes.

"Within 3 months the thing was dead, since nothing was corrected. (...) Nothing was possible with these people; nothing that we came up with could be included. There was no door for it." (Henk Adema)

"We have asked NTS, but you know it is quite difficult to get people to go from here all the way to the Westland for discussions. NTS did not respond to our call for more flexibility because there were fairly recent agreements with INTERMATION, and they did not want to make it too complicated. That is why we started closer to home with a more flexible system." (Jos van Es)

"NTS took the user with the least demands as its point of reference, because otherwise others might drop out. We wanted more, but we were only with a few, and we had so many demands. Besides there were financial limitations, and INFOTUIN was only in its infancy. So SITU/NTS did not want to go with us." (Karel Venneman)

In this period, one of the INFOTUIN users more or less accidentally met with Dirk Noorderling. The latter described this occasion as follows:

"I have a nice anecdote about that. Don't take it too literally but it went more or less like this: My daughter was a member of a pony club, and the daughter of this grower was a member too. Once when I was there, he told me about the unhappiness of the growers with respect to INFOTUIN, and he asked me whether I would be able to do something about that." (Dirk Noorderling)

Although, at this point in time Dirk Noorderling had only little programming knowledge, he was very enthusiastic about the idea of developing an 'automated' ERCS. After some subsequent negotiations with several growers and Karel Venneman, a two year verbal contract was made up in which Dirk Noorderling accepted all substantive grower and extension worker demands (i.e. user-friendliness, flexibility, calculation of parameters according to national standards, surveyability, and rentability). The growers then ended their contract with INFOTUIN. The local auction (which is connected to one of the Westland auctions and therefore financially involved with INFOTUIN) was not happy about this development, and has tried to keep the cucumber growers on board. In doing so, it also refused to electronically provide DACOM with production figures.

"We have been in frequent contact with Westland-West, and they even called us fairly often to urge us not to split off, since one national system would be better. But we wanted a more flexible system, and they weren't able to provide that. (...) Of course there were some disadvantages too; for example the entry of the auction's production data. The auction maintained that INFOTUIN was *the* enterprise comparison system, and refused to electronically deliver data to DACOM. Even now [1991] they still don't." (Jos van Es)

Although some growers feared that a consequence of breaking with INFOTUIN was that they would become even more isolated (i.e. not receive registration material from growers in other regions), the majority agreed that there wasn't much to lose:

"Of course we had to seriously consider the consequences of splitting off. But despite the split off, we would still have the auction's production comparisons. You see, the point with enterprise comparisons is that cultivation comparisons are only interesting if you can see the enterprise as well. There wasn't that much that we could do with the figures from other regions anyway. (...) We preferred to have more data on enterprises we knew, than data of enterprises we did not know.

We weren't really afraid. Because they were pulling at us so badly, we knew that we could always return to INFOTUIN. Thus, there wasn't much to lose." (Jos van Es)

While some had a principal preference for a local system, others -including the extension worker and Dirk Noorderling- look at the development of TELETUIN as an unfortunate necessity.

"I don't mind if every region has its own local program. For IKC [Information and Knowledge Centre; a research liaison office] and the Experimental Station it is nice to have a national system, because they can do a bit of research on it. But that is not the interest of the grower; a grower wants to have influence on his program, and that is best organized at local level." (Jos van Es)

"Of course they [NTS] strive for a national system. I also think that one national system would be best; I am convinced of that. But if certain things become impossible that way you have to try something else." (Karel Venneman)

"I really would prefer to cooperate with NTS. It is purely personal, but when I was a farmer earlier on, I have been active in the farmers' organizations, and I still think that it is important to organize." (Dirk Noorderling)

The procedural dimension; on excessive iteration and 'undemocratic' grower participation

In the 1988-1990 period, numerous versions of TELETUIN have been developed and used for shorter or longer periods. This stream of new versions resulted not only from the many technical problems that rose (many of which were caused by the lack of experience of Dirk Noorderling), but also from the continuous flow of new ideas that emerged in the interaction between Dirk Noorderling, Karel Venneman and growers. Below, I will discuss the contribution of the various actors in generating these ideas, and show how their implementation was decided upon in a rather informal and 'undemocratic' manner.

Dirk Noorderling's initial amateurism and continuing enthusiasm

When Dirk Noorderling started to develop TELETUIN he -in his own description- was 'an amateur'. He indicated that in the beginning he under-estimated the technical problems of making an 'automated' ERCS, and made promises to growers (e.g. that TELETUIN would run not only on personal computers but on simple home computers as well) that -eventually- he could not keep.

"The system shouldn't be on-line, and had to be suitable for MSX, COMMODORE 64 and IBM. They [the growers] formulated those demands, and I promised that I would develop the program accordingly. I didn't have much experience in this field, so I thought that I could easily do that. Well, that proved to be rather disappointing. After one week it was already clear that it would never really work, but since I had promised it I had to make a special piece of software. (...) Look, they wanted graphs, and they wanted MSX, and that cannot be combined, so they had to take it or leave it. It was the same thing with the COMMODORE 64; we never managed to make it work alright, so in the end we had to say, "Sorry, we promised it, but it is impossible". (...)

I was a bit surprised when I read in your report how positively the growers reacted to TELETUIN, as if it was 'their own' system. At the time there wasn't any consideration. I had promised it, so I had to do it. You see, the problem was that the frontrunners especially had MSX computers due to their earlier participation in INFOTUIN, and they were the ones I had to deal with." (Dirk Noorderling)

Due the 'trial and error' process especially at the technical level, growers were continuously confronted with new versions of TELETUIN:

"The number of versions is innumerable. I believe that now we have version 5.3, and I don't recall how many versions 1, 2, 3 and 4 we had. Sometimes we had three or four versions per year. Of course it causes irritations and problems if you find out that your neighbour works with a different version." (Jos van Es)

"Hence, there were quite a few faults in the program, and at a certain moment there were three or four versions operating at the same time. That wasn't great of course. (...) The danger is that a few hobbyists continuously make changes during the season. A grower proposes something to the programmer, and he is enough of an hobbyist himself to try that out immediately. There wasn't always enough discussion about such changes in the past." (Henk Adema)

Nevertheless, both Dirk Noorderling himself and the growers emphasized that Noorderling's amateurism had positive consequences as well. Dirk, for example, indicated that his amateurism helped him to learn at a similar pace and level as the growers:

"In fact TELETUIN consists of two development processes; the development of the programmer, and that of the program. I went through a learning process, and so did the growers. I think this is important for your study. The growers were also just beginning. If I would give the program of three years ago to the growers again, they would chuckle. But at that time they didn't know better, and I didn't either. We have grown up with each other, and then that was possible. In that respect, SEB is now where we were three years ago."

An important advantage for the growers was that Dirk Noorderling -who had an income from his farm, and received benefits on account of his partial (farm)labour-disability- did not charge development costs. The costs for participation were kept at the same level as INFOTUIN, and after paying some fl. 300.- for the original version of TELETUIN, the Drenthe growers received updates for free, even if these included major additions such as facilities for making graphs. His flexibility with respect to the contents of TELETUIN, his enthusiasm, and readiness to work at low costs gave Dirk Noorderling a great deal of credit, and made the growers willing to put up with technical inconveniences. Besides, due to their experience with INFOTUIN and climate computers, the confidence of some growers in professional software developers was not great either.

"You see, Noorderling was an amateur, he thought that everything should be possible, and wanted to put a lot of effort in that. (...) If we tell him: "We want this." he will do it next week if necessary." (Henk Adema)

"The alternative is to go to a professional firm, but even then you have these types of problems. I know from experience that a professional firm is no guarantee for quality. Besides, they ask enormous amounts of money. It is too costly. (...) I know from experience that it takes a long time to develop a program, so he got a few years to play around. By now, I think it needs to be good;

> if I pay for it I want quality. In the early days we didn't pay much anyway. For NTS I would be even more critical, because I don't know the organization." (Pieter Harmsen)

From 1990 onwards, it was decided that updates would only be made once a year. By 1991, DACOM had widened its activities considerably, and employed about six persons. The new employees included marketing staff, for -according to Dirk Noorderling himself- marketing has always been a weak point. The company became much more professional, and started to work in a more formal manner, amongst others with respect to prices, contracts and responsibilities. In retrospect, Dirk Noorderling argued that he will never again develop a software package in the same manner. He will still make sure that he is in close contact with the growers and farmers that he works for, and he has even employed the (now former) extension worker to keep these contacts. Nevertheless, he stressed that he has a lot more expertise now, and that there were many more demands and conditions of his own, for example in relation to the hardware (i.e. computers and modems) used by growers.

Although I will show in the next section that the extension worker has been a significant generator of substantive ideas, and acted as an intermediary between Dirk Noorderling and the growers, Dirk Noorderling himself had a significant influence on the program's contents as well. In the course of 1988, for example, Dirk Noorderling decided to change over from BASIC to CLIPPER, and informed the growers that this implied that graphical representations could be easily provided. Subsequently, this hint resulted in a growers' request to implement such graphs. In general, Dirk Noorderling indicated that it is difficult to determine were the substantive ideas included in TELETUIN originated from. In part this is related to the fact that hardly any documentation on the TELETUIN development process exists (e.g. in the form of technical and/or functional plans, minutes of meetings, etc.).

> "Yes indeed, I always implemented new ideas in the program straight away, and waited for reactions. (...) Although not democratic, it was effective and quick-witted." (Dirk Noorderling)

> "It is difficult for me to analyze where my own fantasy stops and the wishes and remarks of the growers begin. (...) It has all become one big spaghetti, but I estimate that about 50 percent of the ideas in TELETUIN were my own. I am only a spectator in horticulture; I know something about cultivation, but the growers are indispensable. They come up with ideas. But on the other hand, they didn't know anything about computer programs, and their possibilities. So you have to tell them what the possibilities are." (Dirk Noorderling)

Thereby Noorderling indicated that especially in realizing the first operational prototype, the extension worker has played an important intermediary role:

> "I must admit that I never sat around the table with a group of growers to discuss the contents. I already told you that Karel Venneman has been primarily occupied with finding out what growers wanted. Later on, while installing the programs, I have of course had a lot of direct contact with growers, whereby I was frequently sitting behind the computer together with them. Of course, I have an agricultural background, and that makes a difference as well. (...) From those contacts with growers I did get impressions of their ideas and wishes. Of course, I like to create the image that I have developed the program together with growers; I mean that looks good, but it isn't entirely true."

Unauthorized intermediation and testing by the extension worker
In conformity with Dirk Noorderling, the growers also underlined the crucial contribution of Karel Venneman, whereby they emphasize the importance of his almost grower-like insight into cucumber growing:

> "We came a long way with the program. Apart from the technical dimensions, we owe that to a large extent to Karel Venneman. By right, every product needs someone like him, who can translate growers' language into computer language. Karel Venneman is specialized in cucumbers, but in other areas it would be good to have a similar person as well, for I repeat, Dirk Noorderling, of course, is not a grower." (Pieter Harmsen)

Both the growers and the extension worker describe the interactions in which they jointly developed new ideas for TELETUIN as rather smooth, informal and unproblematic.

> "The contents were determined together with Karel Venneman and the excursion-group leaders. We had four excursion-groups, and therein we have discussed things amongst ourselves. The leaders then transferred that to Karel Venneman and Dirk Noorderling. (...) We participated because we had the opportunity to do so. I myself didn't have many ideas about how it should be; the ideas were largely in line with each other. We didn't make problems. (...) We worked with the program as it was. When working on a specific program for cucumbers the ideas don't diverge much; you all run into the same problems." (Henk Adema)

> "The growers were quite easy. They said: "You write down whatever you think is right." (...) You see, growers differ. The frontrunners were really thinking with us, and the others thought it was quite alright. Real general participation was never there. Growers who wanted to think with us participated. I think that about 20 percent was active, and 80 percent accepted whatever was there. (...) Most of the ideas came from the frontrunners and the videotex [ex-INFOTUIN] users." (Karel Venneman)

Apart from his intermediary role, the extension worker -together with Pieter Harmsen- has played a major role in testing the many versions on their technical merits as well.

> "Every version was tested. Dirk Noorderling implemented a design, and I looked at it. I always gave a version to Pieter Harmsen as well. He also was a major hobbyist, and together we picked out the little mistakes." (Karel Venneman)

The superiors of Karel Venneman, however, were far from happy with his heavy involvement in the development of TELETUIN. As was the case with DELAR (see section 8.1), a significant argument was that -in the pre-privatization period- the Ministry did not want the public extension service to be involved with commercial activities.

> "I was doing this all without involving the Service. When it finally came on the agenda within the Service, I had proceeded so far that it could no longer prohibit anything. In that time I was a bit of a frantic dog; I did whatever I wanted. I had a special position, worked independently and there was little control over my time expenditure. When they wanted to whistle me back, it was too late. Enormous discussions followed, but I simply went my own way. There was an element of hobbyism in it. I had a little PC at home, and I was messing about with things myself. (...)
>
> Looking from the angle of the government the Service wasn't happy at all; they were of the opinion that an extension worker could not just go ahead with a commercial firm." (Karel Venneman)

Due to the privatization of the public extension service in the beginning of 1990, Karel Venneman was severely restricted in spending time on TELETUIN, which -according to him- caused bottlenecks in the support and supervision in relation to TELETUIN.

> "Due to the privatization I suddenly had far less time for supervising TELETUIN. Before that it was different. Dirk Noorderling couldn't do it all on his own, so I took a lot of responsibilities off him. When I had less time to spend, things were not going well in enterprise comparisons. (...) I can still make my own working program, but nowadays I have to write everything down, even if I receive a telephone call. Hence, it is increasingly difficult to work on TELETUIN. All that time writing is frustrating; I don't like it. Earlier on we had three extension workers, and now I am on my own. On the one hand, an enormous task aggravation, and on the other, I am restricted. That's why I want to leave." (Karel Venneman)

Apparently the extension worker's job satisfaction decreased during 1990. Thus, he resigned from his job, and started to work formally for Dirk Noorderling from the beginning of 1991 onwards.

Concrete substantive choices and developments

In contrast to INFOTUIN/TVPC (see sections 10.2 and 10.3), and as a logical consequence of its particular history, TELETUIN was developed from the outset in order to cater for the needs of the 'most demanding' growers.

> "We oriented ourselves predominantly towards the top growers. Those are the ones that wish to move on. You cannot direct yourself towards the average grower, because they do not immediately have an open mind towards new developments. (...) First you have to make the top growers participate, and then the rest will follow." (Dirk Noorderling)

However, both in relation to data entry and the different opportunities for data presentation (see section 9.6) TELETUIN was organized in clusters (blocks) of parameters. Although not explicitly intended originally, this proved to be useful for growers with 'less' and/or different demands:

> "In retrospect it emerged that it was an advantage that TELETUIN was organized in blocks. We hadn't purposefully organized it that way, but it was well appreciated. (...) Because TELETUIN consisted of different sub-sections, growers could decide per excursion-group what they wanted to register or not. We directed ourselves to the most demanding growers, and thus we created a framework that suited everybody." (Karel Venneman)

From this, Dirk Noorderling draws a general lesson:

> "I think that first you have to be able to offer a lot, before you can go back to offer less again."

Below, I will briefly discuss some characteristics of the three versions of TELETUIN to which I had access.

The 'ancient' 1988 version

In the first version of TELETUIN it was only possible to retrieve weekly overviews of growers' registration material. When asked why other types of overviews (e.g. overviews of one enterprise over a longer period) were not included, Dirk Noorderling stated:

> "I didn't know better; couldn't do more."

When compared to the 1987 version of INFOTUIN, one sees that (apart from labour parameters) the number and types of parameters in TELETUIN were more extensive; most notably TELETUIN included a greater variety of parameters concerning realized climate and crop-protection. It seems that these extensions -and especially the crop-protection 'block'- reflected locally defined interests (see earlier on for quotes on the interest in realized-climate parameters).

> "You learn a lot about crop-protection. About the choice of remedies -we use a lot of biological remedies, except in autumn- the doses, and the sensitivity of the crop." (Pieter Harmsen)

> "Especially because in due course we need to go to integrated protection, we can learn a lot from enterprise comparison. How can you get rid of diseases with a minimum of chemical means?" (Jos van Es)

Karel Venneman explicitly referred to the fact that their efforts to include crop-protection parameters in INFOTUIN failed:

> "We have two lines per user for crop-protection issues. This was included from the beginning since in this area we find that very important; it is really the section that we use most. I think in the Westland they work a lot more with chemical remedies and perhaps even prohibited means; therefore they were hesitant to include it. In Drenthe we are working a lot on biological means. Particularly in these times it is important to include it, since developments are really hectic."

The 'adolescent' 1989 version

The 1989 version was dramatically different from the 1988 version (see for a detailed discussion of this version, as well as some inconsistencies and peculiarities in it, section 9.6). In addition to the provision of weekly overviews, the program facilitated making overviews of one, two or six enterprises over longer periods. Similarly, several graphical facilities were added, including the opportunity to make graphical comparisons across years.

> "That was probably Dirk Noorderling's idea. The man became more enthusiastic all the time. Towards the end of 1988 we had the whole database of 1988, and then you start thinking about 1989. So in the version for 1989 that was already included." (Karel Venneman)

Although many of the ideas implemented found their origin in growers' comments and demands, Dirk Noorderling and the extension worker often determined the way in which they were implemented and operationalized. This became, for example, clear when interviewees were asked about the clustering of parameters in (different) graphical overviews (see section 9.6):

> "Mind you, there was a certain logic there; there are certain things that you associate with each other sooner than others. There have indeed been discussions about that." (Henk Adema)

> "I have been thinking on behalf of the growers what they wanted to see in one graph. Someone who wanted to put different things together couldn't. I wanted to keep it limited for the more 'average' growers; a type of steering." (Karel Venneman)

> "Yes, that is the same old story. I have put together what I though belonged together. Since I have never had a reaction, I assume that it is still all right." (Dirk Noorderling)

An important addition in the 1989 version was the inclusion of a variety of cumulative parameters. In this example one sees more explicitly, how -in the context of new technological developments and trends- the interactions between growers, the extension worker and Dirk Noorderling have shaped TELETUIN.

> "It is a demand of the growers. Cucumber growers have a cultivation plan of two or three cultivations per year. Especially in the last year three cultivations per year has taken off in a big way. That is an enormous stimulant for looking at periodical cumulatives, and thus making a kind of economical analysis." (Karel Venneman)

> "That was really Karel Venneman's wish. The growers wanted him to calculate periodical cumulatives, so he had to all the time calculate them on the basis of the data that we had in the central computer. So I made a program for it, and now it is directly included in TELETUIN." (Dirk Noorderling)

The 'full-grown' 1991 version

Under the influence of negotiations with the southern cucumber growers and the my research report (Leeuwis, 1990b), several changes were implemented towards the end of 1990 (see section 9.7 for details). Most importantly, the number of parameters that could be represented graphically considerably increased and the combination of parameters included in one graph was no longer predetermined.

> "I think we need to provide a maximum of opportunities. Maybe we used 80 percent of the opportunities in 1989, and only 40 percent in 1990, but the choice needs to be there." (Jos van Es)

> "It may be so that the least demanding grower is less interested. But the program is crystal clear and very user-friendly, so I cannot imagine that the scope of the program deters people. Even if you don't want much you can use it." (Karel Venneman)

When discussing the decision to drop the predetermined clustering of parameters in graphs, Karel Venneman seemed to contradict his earlier statement with regard to his conscious attempt to guide 'average' growers in making graphs.

> "In the TELETUIN committee the message came through that growers wished to see other combinations as well. Then Henk Adema came up with the idea to drop the predetermined combinations altogether. It is such a simple idea, and I never thought about it before."

Dirk Noorderling gave a different version of this episode, whereby he touched on an important development within TELETUIN, namely the inclusion of tomato growers from Brabant/Limburg (see later on).

> "It was my own idea. I wasn't happy with those combinations, or maybe Leeuwis has inspired me to do so. After all it was totally illogical. That change is also related to the tomato program. They have a rigid classification into classes which doesn't match with those of cucumbers, so it was better to disconnect it all."

When compared with the 1991 version of INFOTUIN/TVPC, one sees that TELETUIN did not only add to it (see section 9.6) but also that three significant facilities were still missing, i.e. input control, labour parameters and facilities for making daily comparisons. According to Dirk Noorderling, the control of parameter values (in fact one of the first priorities of the Westland growers with respect to INFOTUIN) has never materialized because it would stimulate the entry of fake values among growers that did not wish to participate fully. Moreover, he felt that securing discipline and equal exchange was a matter of social control within the study club.

> "I'd rather have them fill up a zero, than making it up. Rather a reliable zero, than an unreliable 22 degrees Celsius which falls within the acceptable interval. Even if they enter only zero's they can still receive all the data. It is not my task to act as a police officer. That is a group responsibility. But they have to enter something, even if only zero's, if they want to receive other growers' data."

> "If you participate you are expected to send in your own data, but we never played it hard if someone didn't. May be we should be more strict." (Henk Adema)

Although Pieter Harmsen expressed a clear interest in labour comparisons, most growers were not particularly interested; essentially for similar reasons as the growers quoted in section 9.2.

> "We have discussed it, but the growers didn't feel like it. First of all, it is really laborious, and second, it is very difficult to develop norms and draw practical conclusions. I mean that on each enterprise you work with different types of people, with different levels of experience and force. Some two or three growers here are doing it for themselves." (Karel Venneman)

Similarly, cucumber growers quite generally felt that daily comparisons are not (yet) feasible.

> "It takes too much time. In our own enterprise we do it with the flowers, because there we work with different sections within the enterprise. Moreover, the weekly deviations are almost the same as the daily ones." (Henk Adema)

> "We have philosophized about it, yes. But it was never put forward as a demand. I think everybody is still satisfied with the weeks. Personally, I would find it interesting, but only if the whole input and output is automated. (...) I expect that someday it will materialize. (...) For the moment, however, it would take too much time." (Jos van Es)

Crop-independence and the reorganization of the central database

One of the conditions which Dirk Noorderling had to meet in order to secure the participation of the southern cucumber growers was that those six cucumber growers who were growing tomatoes in the second half of the year, would have to be able to use TELETUIN for tomatoes as well. In 1989, Noorderling had already developed a TELETUIN version for flower growers as well, but this package was basically a separate program, which made use of different fields in the central database as well. However, on this occasion Dirk Noorderling seized the opportunity -after first developing an unsatisfactory provisional solution- to develop a central framework which was fully crop-independent. That is, a database in which each grower -regardless of his or her crop- would have a record of x fields, whereby the field definitions (and the interrelations between them) would vary automatically according to the crop.

The advantages of developing the database in this manner were partly of a technical nature (speed, manageability, etc), but there were also financial and marketing arguments (ease of cheaply developing packages for new crops). Last but not least, Dirk Noorderling was aware that this was the type of database that NTS was looking for in its cooperation with SEB.

> "Once you get different types of growers the relatively small numbers per crop becomes less convenient; (...) it becomes chaotic. In that respect such a large database has technical advantages. Besides, with this development I linked up with the ideas of NTS. They wanted something like this. It is my intention to pull them over the line next year [1991]. Now I already have something that they are still looking for."

In 1991, several software firms (including DACOM) competed in getting the order of building the central database for the new GROEINET system. DACOM, however, was not chosen by NTS to build it. According to Dirk Noorderling this was because the auctions, NTS and SITU still looked at him as an amateur who works with inadequate software and hardware packages.

The costs involved in the development of TELETUIN are hard to measure, and have never been calculated. Especially in the 1987-1990 period, Dirk Noorderling and the extension worker have invested a considerable amount of time in its development. These time investments, however, were never directly paid for, since Dirk Noorderling regarded them as an investment that would somehow pay back in the future, while the Karel Venneman looked at it in part as a personal hobby, and for another part as a legitimate task for a public extension worker. The expenditure on software and hardware during the same time interval were estimated by Dirk Noorderling around fl. 10,000.- in the 1987-1989 period, while in 1990 an additional fl. 50,000.- was invested on replacement and expansion.

Part of the costs made were paid back in 1991 when the number of participants increased dramatically (from 34 cucumber growers in the beginning of 1990 to 83 in 1991) when the southern cucumber study club formally decided to join. While the original participants in Drenthe have never paid more than the initial fl. 350.- for the initial TELETUIN version, newcomers in 1989 had to pay fl. 650.-, while those in 1991 had to pay fl. 1,450.- licence rights (on top of the yearly subscription fee of fl. 750.-). In 1993, the total number of TELETUIN users had grown to 164 (119 cucumber growers, 28 southern tomato growers, and 17 flower growers). In addition, some 110 growers (mainly in the Westland) had bought a special TELETUIN/GROEINET version in April 1993, while some 50 southern tomato and cucumber growers used a postal version of TELETUIN.

10.5 Theoretical and practical implications (part 3)

In the first part of this section I will reflect on how CT-development processes can be theoretically conceptualized against the background of the empirical material. Subsequently, I will derive more practical insights with respect to stimulating CT-development in agriculture and/or horticulture, and the prospects of farmer/grower participation in CT-development processes (practical contribution 5). Afterwards, I will build on my conclusions, and set out to develop a 'learning-oriented' method for CT-development in section 10.6.

The nature of CT-development processes: mutual enrolment, competition, unintended consequences and learning

In all three development histories, one sees that actors are actively involved in enrolling[9] each other in order to pursue the realization of certain 'projects' (as connected with specific interests incorporated therein, see section 5.3).

In the case of INFOTUIN, I have shown: (a) how NTS created and subsequently enrolled SITU in order to get access to Ministerial subsidies; (b) how CAB eventually followed the example of NTS for similar reasons; (c) how SITU -by means of a project proposal- enrolled CAB, CBT and NTS in legitimizing its existence and financial claims. Similarly, one sees in the case of TVPC: (d) how WAB enrolled NTS and SITU in an effort to supplement INFOTUIN with graphical facilities; (e) how NTS and SITU accepted to be enrolled by WAB for the sake of securing unity in enterprise comparisons; and (f) how at a later stage coalitions changed when SEB and NTS enrolled each other in realizing a crop-independent ERCS that would be beneficial to both parties involved. Finally, it can be noticed in the case of TELETUIN: (g) that the local cucumber study club enrolled Dirk Noorderling in order to create a more flexible ERCS; while (h) Dirk Noorderling enrolled the cucumber growers in order to gain experience and establish a commercial software industry.

Clearly, the enrolments described above are a -rather schematically presented[10]- selection. Nevertheless, I think that my case-studies make plausible that in processes of CT-development, numerous enrolments occur through time and space, and that each time a certain exchange of resources (in the widest possible sense; i.e. money, recognition, commitment, legitimacy, participation, access to knowledge and experience, etc.) is implied.

Especially in the cases of INFOTUIN and TVPC, it became clear that the roles which the various actors (are accepted to) play in CT-development processes can become subject to negotiation. For example, while SITU remained to be accepted by most actors (except for the Drenthe cucumber growers) as an 'obligatory passage point' if it came to providing access to financial resources, it became increasingly unacceptable as a partner in deciding on matters of content. In fact, NTS and successive study club representatives managed to reinforce their position as 'obligatory passage points' for making substantive choices, whereby the role of the Westland study clubs was substantially reduced after 1988. Similarly, NTS increasingly became under pressure from DICOTU and SEB to give up its role as developer and distributor of enterprise comparison software, and accept a more facilitating role which was supposedly more in line with its non-profit character.

Hence, it emerges that, although different actors involved cooperate on certain matters in a particular time and space setting, their interests, projects and access to resources can differ considerably, and change over time as well. The same seems to hold with respect to the interpretative, normative and/or ideological schemes that actors put forward and draw upon. The financial manoeuvres of the initial grower participants in the Westland, for example, stemmed from their -partly ideologically based- disgust with bureaucracy and state intervention. Also, NTS's initial policy that INFOTUIN/TVPC should not become too complicated, was not only connected with practical and financial limitations, but also related to 'theoretical' beliefs with respect to the readiness of growers to adopt complex 'automated' ERCS, and to normative/ideological convictions with respect to, for example, the free circulation of registration material in horticulture, and the desirability of preventing increasing differentiation among growers. Similarly, the fact that in TVPC this 'non-complexity' became operationalized by including only 'cultivation' parameters, seems -in part- to be related to the beliefs and convictions of growers in TWG and WAB. During the same period, the interpretative schemes and normative evaluations adhered to by the actors involved in the development of TELETUIN seem to deviate considerably from the ones drawn upon in the Westland.

This latter observation links up with the impression that -although there were various struggles *within* the networks of actors involved in the development of INFOTUIN/TVPC and TELETUIN- competition *between* these networks of actors has shaped the development processes to a considerable extent. That is, the policies, strategies, theoretical beliefs, normative convictions and interventions which were accepted in Drenthe, have to be seen in the context of those accepted in the Westland and De Kring, and vice versa. In fact, both networks of actors seem to have reinforced rather than lessened the competitive dimensions, perhaps in an effort to create an outside 'enemy' in order to enhance local agreement and solidarity (i.e. outsiders and insiders were created). Both the Drenthe and Westland growers, for example, accused each other of 'stealing' ideas. Similarly, several Drenthe growers liked to draw attention to the fact that, despite "obstruction" by "typically Westland" institutions, they have managed to develop their own 'automated' ERCS:

> "INFOTUIN started to more and more resemble TELETUIN, and that is a dirty business. The costs that we incurred were nil, and that is a big frustration in the Westland. Besides, in no time half of the growers participated here. They [the auctions, SITU and NTS] have deliberately tried to leave TELETUIN outside the door. Moreover, the authorities did not render any thanks to the fact that the extension worker has cooperated so well. (...) Here in Drenthe we will stick to TELETUIN; we have a lot to thank that man [Dirk Noorderling] for."

Dirk Noorderling himself -although initially surprised about the growers' commitment to TELETUIN after the many technical problems- confirmed this local solidarity. Thereby he suggested that there are longer standing historical frictions and hard feelings between, on the one hand, the growers in the isolated northern and southern regions and, on the other, those in the Westland.

> "To the outside world they [the growers] did not express the criticisms [with respect to the initial technical problems] that they confronted me with. No western man will know that there are problems with TELETUIN. (...) The growers that left the Westland and went to the North are not taken seriously by Westland growers; in Brabant/Limburg it is the same thing. It is not the average grower that comes here; I suspect that they are the higher level. They are like emigrants, they have

the spirit of pioneers, and they go against the grain a bit. (...) They are doing very well, and also they were the ones that started the cultivation of a third cucumber crop. That causes jealousy."

"When cucumbers are concerned, wisdom comes from the East." (Henk Adema)

Similarly, I have shown in section 10.3 in particular how Jasper Wouters continuously downplayed TELETUIN, and liked to portray Dirk Noorderling as an absolute amateur. Han de Wit (SITU) and Gerrit West (NTS) were much more subtle in their evaluations, and emphasized that DACOM was only a small firm, that was unlikely to be up to date, and likely to have capacity problems. At the same time, it is clear that they have rather conveniently taken over other actors' evaluations in this respect, and never seriously considered to use INSP-LV subsidies to jointly overcome such problems; i.e. they seemed to prefer to keep a certain distance.

"No, we haven't contacted DACOM in relation to the development of TVPC. The growers in De Kring had been in contact with TELETUIN, but they did foresee problems with respect to participation, since TELETUIN couldn't deal with large numbers. We expected that TELETUIN would have to be changed to accommodate large numbers." (Gerrit West)

"I have been at a demonstration meeting of TELETUIN. But DACOM is only a very small firm. INTERMATION, in contrast, is a solid example for the nineties, and is well up to date. You see, TELETUIN is a competitor on the market. (...) They are strong on local systems; with graphs and such. But with respect to the central system that remains to be seen. DACOM may have to face capacity problems." (Han de Wit)

Dirk Noorderling, who in his own view has made openings for cooperation with SITU/NTS on several occasions, remained puzzled about the reluctance of SITU/NTS in this respect.

"Later on I have asked them myself why they didn't spend one telephone call to see whether or not they could get my graphical module. They never gave me a clear answer." (Dirk Noorderling)

In my view, this can best be understood by taking into account that -to a certain extent- INFOTUIN/TVPC as well as TELETUIN were important symbols in wider and longer standing frictions and struggles between the 'centre' and 'periphery' of Dutch horticulture.

In all, it emerges that CT-development processes are complex arenas of negotiation, in which cooperation and conflict need to be looked at in the (historical) context of diverging and changing interests, resource bases, normative convictions, theoretical beliefs, spatial characteristics, etc. That is, CT-development processes emerge as inherently social in nature. Within and through these social processes, actors attempt to create longer term outcomes (e.g. (re)produce certain structural properties), whereby they often try to ensure a particular future role and influence. For example, NTS -like DACOM- wished to play a central role in 'automated' enterprise comparisons, SEB wanted to have its share in enterprise comparison software market as well, the Drenthe cucumber growers wished to create an 'automated' ERCS of which they can effectively influence the contents, etc.

However, although some actors eventually managed to shape outcomes in ways that corresponded to their original goals and interests, the process through which these outcomes were realized was not straightforward. First, one sees that actors had to continuously negotiate with others, and that in these negotiations they were frequently compelled to adapt initial goals, change routes, create new coalitions, etc. Second, actors were continuously confronted with the unintended consequences of their own and other actors' previous actions. SITU/NTS, for example, never anticipated that the choice for videotex and the entering of a three year contract with INTERMATION would severely hamper the flexibility of INFOTUIN and therefore result in the emergence of TELETUIN. Nor did NTS foresee that the creation of SITU and other institutions for the raising and management of funds, would eventually result in a counter-productive institutional mist. Similarly, the Drenthe cucumber growers never imagined that their early participation in INFOTUIN with MSX and COMMODORE computers, would eventually result in many technological problems, delays, and frustrations in the TELETUIN development process.

In part, such unintended consequences arose from limited knowledge and uncertainty with respect to one's own and/or other actors' activities, motives, purposes, strategies, technological achievements, etc. It can be argued, for example, that even NTS and CAB/WAB growers had -at least initially- insufficient discursive awareness of the nature of growers' day-to-day enterprise registration and comparison practices, for if they had had such insight they would probably have spent more effort to develop INFOTUIN/TVPC (both technically and organizationally) into a crop-specific and flexible package from the outset. Similarly, Dirk Noorderling had insufficient insight in both the regional competition, and in the workings of (and/or the interests involved in) INSP-LV subsidized CT-development projects, and has therefore for a long time remained too optimistic about the prospects of becoming a SITU/NTS partner with respect to the development of both a graphical module and a central database.

In the course of the CT-development processes, the actors involved have *learned* about these and other unacknowledged conditions for action, albeit in some cases 'the hard way'. Hence, apart from conceptualizing CT-development processes as social processes, it may - especially for practical purposes, and building on Beers (1991a, 1991c)- be useful to look at them as an inherently social *learning process*.

The prospects for planned innovation, participation and soft systems methodologies

If we conceptualize CT-development processes as inherently social learning processes, we can consider end-user-research and end-user-participation (the key notions in practical contribution 5; see section 6.2) as activities that may or may not enhance such learning. Since the development histories presented in this chapter do not lead to much insight with respect to the prospects of user-research other than those that I have already arrived at in chapters 8 and 9, I will in this section focus on the prospects of user-participation. In section 10.6, I will make suggestions on how both sets of activities may be adequately integrated into a CT-development method (guiding question 21).

It is (in relation to guiding question 19) of interest to note that in all three cases growers have played an initiating role, and have participated intensively throughout the development processes. Similarly, it emerges that eventually the participants involved in the development of INFOTUIN/TVPC (and later GROEINET), and those involved in the development of TELETUIN, have arrived at rather similar insights with respect to what the contents of an 'automated' ERCS should be, and how this could be technically realized. After all, both DACOM and SITU/NTS agreed in 1992 that an 'automated' ERCS would need to be: (a) crop specific; (b) flexible; (c) anticipate diversity; (d) provide local and off-line processing facilities; which (e) include facilities for graphical representation, etc. Moreover, they basically agreed that a crop independent central database which can be accessed through telephone lines should form the basis of such an ERCS, even if they had different opinions on how such a database could best be designed. However, I have shown that the processes through which these conclusions were arrived at were rather different.

In the cases of INFOTUIN and TVPC, one sees that local growers' initiatives became embedded in a formal multi-institutional project at national level. Apart from the numerous already existing organizations and organizational units, various new institutions were established in order to manage the project. Although growers and others quickly learned how the existing packages could be extended and improved, and although -in principle- considerable resources (in terms of money, expertise, etc.) were available, the implementation of what had been learned was relatively slow. The delays in this respect seemed to be caused by: (a) the large number of actors which were (or had to be) involved in decision making, the bureaucracy, and discussions/conflicts about responsibilities which emerged from this; (b) the fact that the availability of government subsidies went along with several organizational and substantive conditions, as well as competition for resources. This contributed to: (c) the formalization of interrelations between various actors by means of contracts, and the fact that many of the actors' contributions (including those of growers) were expected to be paid for; and (d) to the phenomenon that the advancement of the project at national level was granted greater priority than progress made at local level. Moreover, (e) the CT-development method chosen may have slowed down the learning process as well (see my discussion in the next section). Finally, (f) the (initially latent) conflict between SITU/NTS and DICOTU/SEB has affected the speed with which growers' demands could be incorporated.

This latter conflict especially resulted in the abrupt ending of the further development of INFOTUIN and TVPC in 1990, even if functional designs for extensions were completed. As I have shown in sections 10.2 and 10.3, this particular episode has not been the sole moment of frustration among participating growers in the 1985-1990 period. In fact, this and other frustrations and conflicts have led several key grower participants to (voluntarily or involuntarily) discontinue their cooperation. It can be argued that the regional study clubs' participation in the national SITU/INSP-LV project imposed financial responsibilities, modes of working, and decision-making procedures on them, which were rather alien, and therefore easily resulted in such conflicts and frustrations.

In the case of TELETUIN, it can be observed that local growers' initiatives for a long time remained an informally organized local affair. In this particular context it appeared possible to include rapidly (and sometimes even too rapidly) the learning experiences of growers. For this to have happened, it seems of crucial importance that: (a) the programmer was prepared and able to work at very low costs, since he assumed that the investments would somehow pay back at a later stage; (b) the programmer could make use of the (equally low cost) intermediary services of the extension worker, who had considerable expertise in both cucumber growing and growers' learning processes in relation to it; (c) both the programmer and his intermediary frequently visited growers and could actually observe (and ask about) the way in which growers used the available versions of TELETUIN, and thus get an adequate grasp of growers' demands and needs; (d) communication lines were very short, and decisions could be taken almost instantly; and (e) the programmer himself had considerable agricultural experience and feeling for what the cultivation of crops entails. Finally, (f) learning experiences could be incorporated rapidly since the programmer had adopted a much more iterative method of CT-development (see the next section).

Clearly, the development process of TELETUIN was accompanied by frustrations as well; in this case these centred around the many technical problems that emerged, and the institutional reluctance to cooperate. However, these frustrations did not result in a discontinuation of participation on the side of key growers; essentially since they had the feeling that their criticisms were taken seriously, and they could effectively influence the course of development.

When considering the prospects of soft systems methodologies (see sections 3.3 and 4.2) as a means of enhancing joint learning and reaching higher quality collective agency in CT-development processes, my case-studies show that such methodologies may be associated with several drawbacks and pitfalls. These drawbacks and pitfalls are related to the social dimensions of joint projects and learning achievements, and as such they are not unique to soft systems methodologies. Nevertheless, it may be particularly relevant to mention them in relation to them, since several soft systems thinkers seem insufficiently aware of the social dimensions entailed (see sections 3.3 and 4.2).

Most importantly, it emerges that a significant pitfall may be that boundaries of 'human activity systems' (HAS) (Checkland, 1981) are too widely chosen. In the case of INFOTUIN/TVPC, for example, one sees that -as soon as it became a national project- a wide array of actors were defined (and/or defined themselves) as belonging to the HAS. In addition to a variety of institutions, these actors also comprised a wide variety of growers, which included not only several types of glasshouse fruit-vegetable growers, but also flower growers and (be it in the background) even non-glasshouse vegetable growers. Partly as a result of this, the CT-development process regularly stagnated (at least from the perspective of the participating growers), and the 'consensus' that was reached on what had to be done frequently amounted to a compromise that only few actors were really happy with. Also, I have shown that 'consensus' and compromises were indeed reached under the influence of several 'external pressures'[11] (e.g. subsidies and the conditions associated with them, pressures from growers with different crops and/or from other regions). However, it has at the same time emerged that such 'consensus' was sometimes mainly a strategically maintained 'lip-service' in a particular time and space setting, which easily disappeared in other contexts. In contrast, it can be concluded in the case of TELETUIN that the boundaries of the HAS were drawn much narrower, and in such a way that both the number of -and the diversity among- actors included was considerably reduced, while other potentially relevant actors were identified as competitors. This choosing of boundaries resulted in considerably fewer frictions and contradictions throughout the CT-development procedure.

In essence, one sees that efforts to create negotiated 'consensus' may have counter-productive consequences when boundaries are chosen in such a way that actors with too widely diverging goals, interests, convictions, etc., are included. In the context of CT-development, the case-studies suggest that this may be especially so during early stages of innovation processes; that is, when the scope and need for learning is largest due to a lack of experience. It could be argued that the early incorporation of the Westland and De Kring growers' initiatives in a national project resulted, on the one hand, in a frustration of their learning process, and on the other, in large investments in CT that were technically, organizationally and in terms of contents insufficiently mature.

The illusion of planning, and the gradual difference between prototyping and formal CT-development methods

From the above observations and analyses, it emerges that the idea that the development of CT can somehow be planned in a straightforward and predictable manner is misleading.

At the level of government efforts to stimulate the use and development of CT in agriculture (see also chapter 7), it can be noticed that -although policy plans (Ministry of Agriculture and Fisheries, 1984), project proposals (SITU, 1987, 1989) and progress reports (SITU, 1989, 1990) frequently suggest differently[12]- the realization of predefined goals does not smoothly follow from the employment of means and the execution of previously designed plans. As I have argued earlier, goals tend to be rather fluid, diverse and conflictive. Similarly, outcomes can be rather unexpected and unintended, while action plans and procedures are (re)negotiated continuously. Hence, one sees in the cases of INFOTUIN and TVPC how the Informatics Stimulation Plan eventually invoked organizational arrangements, conflicts and decisions that at times *obstructed* rather than stimulated the development of an appropriate innovation in that the integration of learning experiences in these CT was considerably slowed down. Similarly, the allocation of INSP-LV resources to the SITU/NTS project has reinforced structural properties (e.g. the continued commitment of growers to a prospective NTS-supported national 'automated' ERCS), which made it rather difficult for autonomous competitors to enlarge their share of the enterprise registration and comparison market.

An essentially similar argument can be made with respect to formal CT-development methods. The CT-development method applied in the case of TELETUIN fits neatly with Vonk's (1990:22) definition of *prototyping* in that a highly informal, interactive, iterative and participatory procedure was 'adopted', in which many different prototypes were successively evaluated (see section 7.4 for details). In contrast, both INFOTUIN and TVPC were developed in an 'incremental' or 'modular' development procedure, whereby the subsequent modules were designed and implemented in a largely project-oriented manner (see section 7.4). Although again, the actual procedures followed in the cases of INFOTUIN and TVPC were far less straightforward than literature on project-oriented methods prescribes and/or describes (Bots et al., 1990; Turner et al., 1988), I have shown indeed that -especially from 1989 onwards- detailed written functional designs preceded the actual building of a module. This procedure implied that the participation of growers took place primarily during the making of a functional design, while the prospects of making substantive adaptations *after* the implementation of this design were extremely limited. Hence, it can be concluded once more that the efforts to systematize and plan developments from the outset prevented the rapid inclusion of learning experiences.

Several authors stress that the much more flexible and informal prototyping method is especially suited for situations in which there is high uncertainty with respect to user demands (Vonk, 1990:53-54)[13], or -in other words- when uncertainty with respect to both the problem and the outcome of CT-development is high (Bots et al., 1990:404). Hence, a link is made between uncertainty, the nature of the problem (structured or unstructured) and the choosing of a development method (see also Davis & Olson, 1985:564-565). In section 7.3, I have already argued that the idea that problems can be unambiguously 'structured' is rather misleading, and thus that truly structured problems do not exist. Moreover, the case-studies presented in chapters 8 and 9 clearly show that CT like DELAR and ERCS (which incorporate characteristics of both Feedback System, Extension Supporting -or Replacing-Systems, and Network Systems) have more to do with the *invention* and *identification* of problems, rather than with the direct *solving* thereof, which can be described as anything but 'structured' activities (see section 9.8). If, on top of this, one recognizes that the frames of reference which farmers and horticulturists draw upon are quite likely to divert considerably from those of CT-developers (i.e. there is -in Vonk's (1990:54) terms- a high risk of communication problems), and that agro-informaticians quite generally admit that insufficient insight on farmers' and growers' actual information needs exists (see chapter 2), it can be concluded that prototyping emerges as quite a suitable CT-development strategy for quite a wide array of agricultural CT.

In fact, the case-studies show that even if initially the user demands may seem quite clear, they are rapidly changed and modified as soon as a CT becomes operational. In all three case studies it can be noticed that the assessment of the parameters that were to be included followed quite logically from the existing postal ERCS and the experiences with the available versions of the automated ERCS. However, the speed at which these insights could be incorporated varied considerably due to the organizational arrangements (see earlier on) and CT-development methods adopted. This observation underlines once more the cruciality of the external design of a CT (in addition to its internal design) for the successful operation and development of CT (see also sections 8.6 and 9.8).

An objection that is frequently raised against prototyping is that the process is hard to manage because changes occur frequently (Davis & Olson, 1985:570). Also, it is often argued that after a number of iterations, a prototype usually develops -from a software-technical point of view- into an inefficient and unsystematic 'jungle', which needs to be completely rewritten after a while. Gerrit West (NTS), for example, argued:

> "With prototyping you have a large risk of developing a child with water on the brain; you always need something like an information model to prevent that."

Indeed it was shown in the case of TELETUIN that such a major rewriting occurred during 1990, but in the case of INFOTUIN/TVPC it was also decided in 1990 to develop a completely different CT altogether. Hence, one sees that changes in interests, requirements, technological opportunities and institutional settings, etc., can be so rapid that systematically developed packages need to be completely replaced at a similar pace as increasingly chaotic prototypes. In the meantime, however, the methods adopted in the case of INFOTUIN/TVPC have contributed to its relative inflexibility with respect to matters of content. In a way, the main difference between the prototyping method adopted for the development of TELETUIN, and the project-oriented methods adopted in the case of INFOTUIN/TVPC, then, was that in the former new experiences could be incorporated at relatively small time intervals, while such time intervals in the case of INFOTUIN/TVPC were considerably larger. Hence, we can speak of a gradual -but nevertheless significant- difference.

Conclusion: towards a 'learning-oriented' method
In all, it emerges (in relation to guiding question 21) from these elaborations that at least in the early stages of CT-development efforts which are aimed at farmers and horticulturists, a prototyping-like method seems crucial for the facilitation of learning on how such a CT should eventually be internally and externally designed. This proposed *'learning-oriented'* method contrasts with present practices in agro-informatics, for I have shown in section 7.4 that 'project-oriented', 'process-oriented' and 'data-oriented' methods dominate. Furthermore, it seems relevant to choose the participants in such a prototyping process in such a way that differences in interests, goals, convictions, etc., can be accommodated. For making such choices, the type of user-research presented in chapter 9 can be useful (see section 9.8). Hence, it seems indeed that both user-research and user-participation emerge as crucial elements for agricultural CT-development procedures (guiding question 20).

Finally, it is clear that such flexible and informal learning processes require certain organizational conditions (guiding question 22), for we have seen that it can be counterproductive to try to formalize learning processes. Ideally, prototyping efforts should in my view be embedded in an organizational setting in which: (a) communication lines are short; (b) decisions can be taken rapidly; (c) actors are prepared to work quickly and cheaply; (d) access exists to sufficient software and hardware resources and experiences (e.g. advanced tools for making prototypes); and (e) the development process can be -at least temporarily- shielded from external conditions, interventions and/or formal planning.

In the next section I will -perhaps somewhat paradoxically-elaborate in more detail how CT-development projects could be organized ('planned') as a flexible and multi-stranded learning process.

10.6 User-research, user-participation (part 1), and the social scientists' contribution (part 3) in a 'learning-oriented' CT-development method

In this section, I will integrate the practical insights that I have gained from the various case-studies presented in this book into a 'learning-oriented' CT-development method. This method incorporates elements of both 'user-research' and 'user-participation', and spells out the contribution that social scientists can make in relation to this. Hence, this section provides answers in relation to practical contribution 5 and guiding questions 25 and 26. (see section 6.2).

In essence, the conclusion that can be derived from the previous section is that, if CT-development processes are learning processes, it makes sense to *organize* them as such. Hence, I am of the opinion that it is unhelpful beforehand to define in detail what the end results of such a process should be. At the same time, it is impossible to start a CT-development procedure without some sort of a preconceived idea of what might be useful and feasible. Not surprisingly, therefore, one sees in practice that a CT-development procedure often starts when someone wishes to investigate seriously the prospects of realizing a particular *idea* for developing a CT, rather than with a completely open phase of CT-identification, goal formulation and/or problem definition.

In the approach outlined below, I will take this common procedure as my starting point, and assume that such a preliminary idea is developed and/or picked up by some more or less 'external' intervener ('external' in the sense that they themselves are not the end-users) that wishes -partly on behalf of others- to build a CT. This is a significant assumption, since it means that -in contrast to many other actor-oriented researchers- I choose to take the risk of developing a tool for 'interventionists' which may help them to operate more effectively. At the same time, however, the methodology can be looked at as a tool that may improve the potential for those that are subjected to intervention to influence more adequately such interventions. Also, the choice to write down the 'learning-oriented' method in a way that caters for the needs of 'external' interveners, by no means excludes the possibility that it can be applied by and/or on behalf of groups of end-users in a similar way as described in chapter 9.

Despite the fact that my experiences show that learning can be obstructed by rigid planning, I think that it is useful to present the 'learning oriented' method in a stepwise fashion[14]. For most steps in the method, I will mention some questions which may be relevant to reflect upon in relation to it. Although I am aware that it is fundamentally impossible to provide unambiguous answers to such questions, and/or generate answers with a definite predictive value, I still think that it is an useful effort to reflect on them. Thereby, the *process* of posing the question, and trying to find different answers (originating from different perspectives and micro-contexts), has a value of its own, and may result in insights that help us to pursue social change more effectively.

Step 1: The generation of an initial idea

In many cases initial ideas for developing a particular CT 'simply' emerge within a specific social context. That is, one or more actors -from their particular perspective and interest- expect that the development of such a technology will be beneficial (in the widest possible sense) for themselves and/or others. In some cases (or stages) initial ideas are less concrete in nature. In the context of agriculture, for example, I have shown that the initial idea of external interveners was basically that farmers could benefit from using CT in general, and that Standard Information Models were developed amongst others for the identification of different potential 'information (sub)systems' (see section 7.4).

However, external interveners could also generate such more concrete initial ideas in a less deductive manner. One could, for example, search for and explore the (often local) initiatives that different actors (e.g. farmers, study clubs, extension workers, etc.) in a particular domain are already engaged in. Although my 'learning-oriented' method implies a thorough screening of both deductively or inductively generated ideas, I am of the opinion that the use of inductive identification procedures is probably most efficient, since the ideas generated on the basis of it may have a greater chance of being rooted in day-to-day social practice than the deductive conceptualizations of an external intervener (see sections 7.4 and 7.5).

Box 10.1: **Introspective questions for the external intervener(s)**

- From whom does the initial idea originate?
- What do we expect the added value of the CT to be, i.e. to which problematic situation is it an answer?
- For whom is the existing situation problematic and why?

- Do other actors involved perceive the existing situation as problematic as well, and why (not)?
- What are the assumptions which underlie our expectations?
- Which other actors have taken initiatives in solving the problematic situation, how and why?

Step 2: An actor-oriented study of feasibility and desirability

Already at this early stage it is important to bring in social scientists in order to evaluate the feasibility of the initial idea. Apart from making an overall assessment of the feasibility, this step is primarily aimed at identifying an appropriate set of actors for participating in a prototyping process (step 3), and at generating initial design-criteria which allow for the construction of a relatively advanced (in terms of its anticipatory qualities) first prototype. In my view social scientists could proceed in the following manner: (a) identifying relevant actors; (b) identifying relevant practices; (c) generating a variety of classifications of actors, based on diversity in concrete practices; (d) exploring the social dimensions of diverging practices; (e) developing criteria for internal and external CT-design from the perspective of different categories of actors; (f) assessing the potential added value of a CT with respect to different practices and categories of actors; (g) identifying a target-category with an appropriate level of diversity; and (h) assessing the overall feasibility of the idea.

Before elaborating on these different sub-steps, it is important to note that a CT-development process is an inherently political and normative activity; that is, the issue of desirability cannot be ignored. Hence, before engaging in such a feasibility study, an actor-oriented researcher (like all other actors involved) will have to take a politically and normatively-laden decision on whether or not to be enrolled (and by whom).

Keeping in mind that many CT-development projects have failed, the social scientist has the explicit task during this step to be as critical as possible. In fact, he or she should play the devil's advocate, and attempt to 'prove' that the proposed CT will be utterly useless. Hence, it may be an advantage to look for a preferably independent social scientist who shows a healthy dose of scepticism. Of course I am aware that this latter suggestion may have a threatening dimension for the actors or institutions that pursue the realization of a particular idea. Nevertheless, I think that the past has taught us that such a critical assessment is necessary. Whether or not such studies can be realistically carried out depends to a large extent on the genuine interests of the various actors involved, their political and normative convictions, and on their capacity to establish mutual relations of trust.

Provided that enough space for critical research can be secured, I think that social scientists -in deciding whether or not to become involved at this early stage- would do wise not to take their decisions in this respect on the basis of strongly preconceived ideas on what is 'politically' and/or 'normatively' 'correct'. Such a (frequently observed) attitude stimulates systematic forms of professional ignorance, and deprives them of the opportunity to learn and influence social change in a desired direction.

Box 10.2: **Matters of consideration for the researcher (and other participants)**

- Do I agree with the purposes and interests that are associated with the project?
- Are there -at first glance- actors involved whose interests I would like to serve?
- Does sufficient space exist for doing independent and critical research?

- Am I sceptical enough to do this study, and positive enough to contribute to the development if this appears feasible?
- To what extent are my own attitudes and motives in relation to this study influenced by normative and political pressures by others?

Step 2.1: Identifying relevant actors

Naturally, it depends on the nature and scope of an initial idea, and on the intervention context in which it emerges, which actors can be deemed relevant. As a starting point, it seems useful to initially focus on those actors that are thought to be directly involved in the use of a particular CT, i.e. the farmers, growers and extension workers that are supposed to use and/or supervise the would-be CT. More than likely, it will appear during the subsequent steps that the interactions in which CT are supposed to be used cannot be looked at in isolation from other interactions in which other actors are involved as well. In some cases it may be sufficient to explore the consequences of such more or less simultaneously occurring interactions for the use of a prospective CT by means of qualitative interviews with end-users and/or participant observations of existing interactions (e.g. in case of the role that commercial extension workers and/or contacts at auctions play in relation to enterprise registration and comparison practices, see section 9.4). In other cases -especially when the immediate interests of third actors appear to be involved- it may be useful (in some cases at a later stage) to include them in the empirical explorations (e.g. in case of the role that the developers of climate computers aspired to play in relation to enterprise registration and comparison practices, see section 10.3). Finally, an actor oriented researcher will need not only to look at the intervening party (in many cases his or her direct employer) as a relevant actor, but also at his or her own position in this respect.

Box 10.3: **Guiding questions for the researcher**

- Which actors are supposed to communicate with whom by means of the proposed CT?
- Which actors do thereby play an intermediary role?
- What is supposed to be communicated in these interactions?
- What other actors (wish to) communicate with the end-users on similar issues?
- How may other actors be affected by the development and use of the proposed CT, and how may they react?
- What is the role of the intervening party, and how do the various actors perceive the intervening party?
- Which actors do I eventually want to work for, and how do the actors involved perceive the researcher?

Step 2.2: Identifying relevant practices

An initial idea for developing a CT usually relates to a particular domain or field of activity. Almost inherently such an idea is based on the assumption that a CT has in one way or another an added value when compared with the already existing communication practices. At this stage in the feasibility study, the social scientist has -by means of a series of exploratory qualitative interviews and/or participant observation- to identify significant recurrent practices that either directly constitute, or else seem to be related to, a particular field of activity. As I have shown in chapter 9, such practices are not necessarily 'communication practices' (or other knowledge and information-related practices), but can also relate to other fields of activity that are connected with such practices; in this case the horticultural *production* practices that the communicative interactions were about.

It is hard to give exact guidelines on how to determine which practices are significant, relevant, and/or crucial. In my experience, the most significant practices are: (a) those that constitute different responses of actors towards situations that -superficially speaking- look rather similar; (b) those that actors try to hide away; (c) those which surprise the researcher; (d) those that actors expect to change in the near future; and (e) those around which conflicts and/or irritations exist. In many cases, one will find that these are the practices that arise in contexts where discontinuities in normative values and social interest exist; that is, those that ensue at social interfaces (see section 6.3). Despite all these hints, it is clear that this stage of the learning-oriented method clearly requires a considerable amount of skill, creativity and intuition on the side of the researcher.

Box 10.4: **Guiding questions for the researcher**
- Which existing practices constitute (and/or are related to) the field of activity in which the proposed CT is to play a role?
- What practices are the CT-mediated interactions about?
- Which practices can be looked at as different responses to at first sight similar situations?
- Are there areas and/or practices that actors are reluctant to speak about?
- Which practices did I not expect to find?
- Which are the practices that (other) actors are angry and/or disappointed about?
- What practices do actors expect to change in the near future?
- Which practices emerge at interface situations?

Step 2.3: Generating a variety of classifications of actors, based on diversity in concrete practices

Building on the practices that are identified in step 2.2, the researcher is to develop a variety of classifications of actors, which are rooted in the different practices that they tend to engage in while operating in situations that appear similar at first sight. The purpose of such contextual classifications is not so much to assess the distribution of actors over the different categories (even if at some points in the analysis this may be useful), but rather to serve as temporary analytical (and sometimes also idealtypical) distinctions that help to focus further exploration.

Box 10.5: **Guiding questions for the researcher**
- Which diverging practices seem most significant and/or hard to explain?
- Do actors in the field recognize these differences as meaningful?

Step 2.4: Exploring the social dimensions of diverging practices

An exploration of the social dimensions of diverging practices entails two complementary research strategies. First, my theoretical framework suggests that such an exploration implies an analysis of the (repertoires of) rules of interpretation, normative rules and resources -i.e. modalities of structure- that actors draw upon in the (re)production of such practices. Second, the inherent connection that I propose between making classifications of actors and identifying diverging practices, implies that an analysis of the social dimensions can be further completed by identifying more 'traditional' characteristics of those who engage in different practices. Thereby, one can think of productive results, demographic variables, communicative predispositions, etc., but also of other practices that these categories of actors are or are not engaged in (see sections 8.3, 8.4 and 9.4). While this latter research strategy can be pursued with the help of a combination of qualitative and quantitative research methods, it is clear that the former strategy primarily involves qualitative methods such as qualitative interviews and participant observation.

Box 10.6: **Guiding questions for the researcher**

- What rationalizations do actors express in relation to their practices?
- What is the history of the practices that the different actors are engaged in, and do actors expect that they will be changed in the future?
- What reasons do they express for not doing what others do?
- What strategies, 'projects' and/or uncertainties are associated with actors' practices?
- What are considered to be resources by the various actors involved, how are they distributed, and to what extent do actors engage in struggles in order to change this distribution?
- What resources do actors bring in, in order to reach which outcomes?
- How do actors explain their practices in terms of their relation with (and/or evaluations of) other actors?
- How are other diverging practices quantitatively distributed over different categories of actors?
- How do actors themselves connect particular practices with other practices in time and space?
- What normative convictions do actors express in relation to their practices?
- What problems do different categories of actors experience in the existing situation?
- How do different actors think that their particular situation could be improved, and which actors are considered as a threat to the realization of their interests in this respect?
- What are the models and assumptions that are implicit to the proposed CT (see amongst others section 7.3)?
- How do the practices and rationalizations of the various actors compare with these models and assumptions?
- What are the characteristics associated with particular categories of actors, how can these be interpreted, and what are the interpretations of the actors themselves in this respect?

Step 2.5: Developing criteria for internal and external CT-design from the perspective of different categories of actors

In essence, the researcher has in step 2.4 developed a series of *contextual profiles* of the different categories of actors involved. These profiles include: (a) different interrelated sets of practices that actors engage in; (b) different repertoires of rules and resources that they draw upon; (c) various types of characteristics associated with the different categories of actors involved; and (d) an identification of the 'projects' that they pursue.

At this point, it becomes pertinent for the external interveners and the researcher to define more precisely which *knowledge and information-related practices* the prospective CT might support (rather than assess which concrete information needs should be catered for by this tool, see section 9.8). As appeared in section 9.4, it is possible -on the basis of above mentioned profiles- to formulate preliminary design-criteria that any such tool or CT might have to meet in order to be supportive of the various categories of actors that are distinguished. There is nothing metaphysical about the formulation of such criteria; when using a bit of common sense they can be easily extrapolated from such profiles. It may be useful to keep both the types of CT mentioned in section 7.3 and the models that are often incorporated in them, in the back of our minds when thinking about design-criteria.

Box 10.7: **Guiding questions for the researcher and external interveners**

- Precisely which knowledge and information-related practices do we wish to support ?
- What type of CT is implied?
- Which of the models mentioned in section 7.3 are involved, and which requirements can be formulated in relation to them?
- What are the requirements in terms of software and hardware design that a CT would have to meet in order to be supportive for each of the separate categories of actors?
- What are the requirements in terms of organizational arrangements (supervision, training, costs, arrangements for securing flexibility, decision-making procedures, etc.) that a CT would have to meet in order to be supportive for each of the separate categories of actors?

Step 2.6: Assessing the potential added value of a CT with respect to different practices and categories of actors

Even if in a particular case it appears possible to arrive at concrete design-criteria as meant in step 2.5, this does not automatically mean that it is sensible to develop one or more CT in accordance with these criteria. It is quite possible that -from the perspective of one or more categories of actors- such a CT has little or no added value when compared with existing arrangements in that particular field of activity, or that problematic aspects can be alleviated in a much more simple manner (e.g. with more 'traditional' media). Also, it may be that the analyses indicate that unanticipated adverse consequences are likely to occur. In making a balanced assessment of the potential added value, however, one should not only take into account the advantages that the external interveners had initially foreseen, for it may appear (as I have shown in chapter 9) that the originally expected advantages prove less valid, while other more plausible advantages unexpectedly emerge.

Box 10.8: **Guiding questions for the researcher**

- How valid are the initially anticipated advantages against the background of the profiles of the different categories of actors?
- What unavoidable disadvantages are likely to occur following the introduction of the prospective CT?
- To what extent can the CT alleviate problems which are experienced by different categories of actors in the existing situation, and which unforeseen advantages may thus be associated with it?
- What alternative solutions exist?

Step 2.7: Identifying a target-category (or coalition) with an appropriate level of diversity

In this step, the researcher will -on the basis of the various classifications of actors, profiles, design-criteria and expected added values- have to determine for which cross-section(s) of actors it may be realistic to develop one overarching CT. Since the researcher will usually have different options in this respect, it will be clear that the making of such a selection is an inherently normative and political exercise.

Apart from the expected added value, the terms 'realistic' and 'appropriate' in this context have various additional dimensions, which need to be looked at simultaneously. First, the researcher will have to look at the extent to which design-criteria associated with different categories of actors are contradictory and/or mutually exclusive. Second, this first assessment has a clear technological and historical dimension. Technological opportunities change over time, and the same holds for actors' experiences with particular technological packages. The cases presented in chapters 9 and 10, for example, show that the prospects for developing one CT for a greater variety of actors quite rapidly increased due to both experiences and insights gained with more narrowly targeted CT, and new technological developments. This shows that design-criteria, which may be effectively mutually exclusive, can become more compatible in the course of time.

A third dimension of 'realistic', which also derives from these cases, is the extent to which different categories of actors (e.g. vegetable growers and flower growers, or cucumber growers in Brabant/Limburg, the Westland and/or Drenthe) have overlapping interests, and are practically able and/or prepared to cooperate with each other (i.e. form a *coalition*) at a particular point in time. Similarly, what is realistic depends also on the resources that actors (including the interveners) have (or wish to make) available for CT-development, i.e. for meeting the associated criteria for internal and external design. Finally, what may be a suitable target-category with an appropriate level of diversity depends on the extent to which representatives of this category can be actually identified and approached for participation in a prototyping process. As I have discussed earlier on, the classifications of actors that I propose to make are to an important extent analytical tools. Although it would be possible actually to allocate different actors to categories related to some of the classifications, this may be impractical for less stable, more subtle or relatively idealtypical classifications. Moreover, particular classifications may not correspond with the lines along which actors are organized in institutions that cannot be bypassed (e.g. study clubs). Similarly, classifications may be considered illegitimate to serve as a starting point for CT-design by the actors involved.

Following these analyses, the intervening party will -if resources are limited- have to take a political decision on which cross-section(s) of actors will be given priority with respect to the direction of CT-development efforts. Clearly, the social scientist has a clear opportunity to influence the interveners' perception in this respect.

Box 10.9: **Guiding questions for the researcher**

- For which categories of actors can sufficient added value be expected in order to justify the various types of investments needed?
- Which design-criteria are mutually exclusive in the short and medium term, and what are the consequences of this with respect to the cross-section(s) of actors that can be selected as a composite target-category.
- What can be learned from existing experiences?
- What are the prospects of present technological opportunities, and which developments can be expected in the near future?
- Which cross-sections of actors can potentially form a coalition. Which conflicts and competitive aspirations may be associated with such coalitions, and which of these conflicts and aspirations may become productive in processes of CT-development.
- Which cross-sections (or coalitions) of actors are willing and able to cooperate in a collective prototyping effort (step 3)?
- What are the limitations posed by available resources?
- Which categories of actors can practically and legitimately be approached for participation in a prototyping process?

- For which cross-sections of actors is CT-development most desirable?
- Which cross-section(s) of actors should be given priority and why?

Step 2.8: Assessing the overall feasibility and desirability of the idea
If one or more composite target-categories have been identified for which it is plausible to expect that an overarching CT may be realistically developed, the time has come to decide whether or not, (and how) to proceed with the idea, or an adapted version thereof. Hence, the question of whether or not to continue will need to be explicitly asked and discussed.

At this point, three additional considerations need to be taken into account. First, one needs to explore whether the relevant actors can actually be enrolled. Second, one needs to evaluate whether the conditions under which the various actors (including the intervening party itself) are prepared to cooperate and contribute resources are conducive for starting a prototyping process in which learning experiences can be rapidly incorporated in CT-design (see section 10.5). Third, an assessment needs to be made of the resistance and obstruction that might be invoked by continuing the project, and on whether or not it is worthwhile to take on the struggle.

Box 10.10: **Matters of consideration for the external intervener(s) (and other participants)**
- Are the relevant actors willing to cooperate and under what conditions?
- Taken together, are these conditions likely to: (a) imply that communication lines remain short; (b) facilitate rapid decision making; (c) ensure that actors will work quickly and cheaply; (d) guarantee sufficient access to software and hardware resources and experiences; and (e) ensure that the learning process can take its own course, and will not be subordinated by ukases and/or rigid criteria for evaluation that must be met at any cost.
- Which actors can be expected to resist and obstruct our efforts, and what is their chance of succeeding to do so?
- Is there sufficient reason to continue the CT-development procedure?

Step 3: Prototyping and field testing

If indeed the social scientist has failed to make plausible that the proposed CT will be utterly useless, the actors enrolled can actually begin to develop one or more internal and external CT-designs (in the latter case either with or without the expectation that the different designs will at a later stage grow towards each other). In my view, the internal design can be best developed by means of a prototyping procedure (see section 7.4 and Vonk, 1990), while the external design can be suitably developed during field testing. In both steps, the social scientific researcher can play a role in the monitoring and evaluation of the process, and in doing additional research if necessary.

Step 3.1: Prototyping
A prototyping process starts with the instalment of a prototyping team, which needs to be composed of at least programmers, delegates of the various categories of end-users involved, and -in many cases- strategically chosen intermediaries (e.g. extension workers and/or social scientists) which are well acquainted with the field of activity. The number of end-users in the team is to be determined in a contextual fashion, and depends amongst others on the level

of diversity within the various categories of end-users involved, and the type of CT (obviously one needs a larger group of delegates when speaking about a Networking System). Preferably, the majority of delegates should be more or less representative for the categories of actors that they are supposed to represent, but it can also be extremely useful to include actors which have special interest and/or experience (e.g. as a result of earlier initiatives). In order to get the project off the ground, ensure actors' participation, and reduce the possibility that delegates invest heavily in software and hardware that -in the course of the learning process- may appear inappropriate, it may be necessary to provide them with such facilities against a reduced rate, and/or provide them with other rewards.

After an initial discussion within the team of the criteria for the internal design that were deemed relevant to the composite target-category by the social scientist, the programmers can start to build a first prototype that is in line with agreed upon criteria, and -depending on the complexity of the proposed CT- more or less complete. This prototype can then be tried out by the end-user representatives, whereby their experiences are both recorded by the intermediaries during qualitative interviews and participant observations, and discussed at the meetings of the entire prototyping team. Subsequently, this team can decide upon (i.e. negotiate) necessary changes, extensions, etc. After numerous iterations of this type, the prototyping team is supposed to deliver a version that is mature enough to be tested in the field.

Box 10.11: **Matters of consideration for the external intervener(s) and the researcher**

- Which actors can act as intermediaries during the prototyping process?
- Given the level of diversity and the type of CT proposed, how many participants do we need, and how can we select representative delegates?
- Which actors are of particular value because of their interest and experience?
- What are -from the perspective of the delegates- the risks involved with participation, and how can these be reduced?
- Which of the initial criteria for the internal design formulated by the social scientist in behalf of this composite target-category, are considered valid by the prototyping team?
- What are the practices that actors engage in while using the CT, and what are the consequences thereof for previously existing practices? (See also guiding questions for the researcher in step 2.4).
- Which new criteria for CT-design emerge?

Step 3.2: Field testing

Since the prototyping team is inherently involved in a very intensive process in which all sorts of special arrangements (e.g. supervision, feedback, services, rewards, etc.) exist, the prototyping team is (i.e. increasingly becomes) notoriously unsuitable for designing an adequate external CT-design which has a reasonable degree of validity in relation to the composite target-category as a whole. While in the meantime the prototyping team continues its activities, it is therefore necessary to test a reasonably mature version of the CT under field conditions. That is, the CT is tested with an external design (i.e. arrangements for supervision, training facilities, support, costs, etc.) that can be realistically maintained if -at a later stage- the CT would be adopted widely. Hence, preferably a representative group of actors needs to be selected in order to test the CT with the view of designing an adequate external design.

Again, the design-criteria deemed relevant by the social scientist for the composite target-category can serve as starting point. During the test, the adequacy of these criteria can -at several points in time- be evaluated by the social scientist with the help of similar methods as proposed in step 2 (qualitative interviews, participant observations, etc., see also section 6.3). On the basis of this evaluation, the external design can already be adapted (and re-evaluated again) during the field test.

In order to secure the participation of members of the first testing group it may be unavoidable to compromise on the 'under-field-conditions' requirement, and somehow reward them with special arrangements for serving as Guinea-pigs. However, I propose to limit such compromises to the minimum, and search for compromises only in the financial sphere. To the extent that bottlenecks in the external design can be alleviated in the internal design, the experiences gained in the field tests are to be communicated to the prototyping team. In a second field test (i.e. after completion of a more or less 'final' prototype), the second testing group should in my view be strictly subjected to field conditions.

Box 10.12: **Matters of consideration for the external intervener(s)**

- How large a testing group do we need, and how can we select a representative testing group?
- What are the minimum special arrangements and services that we need to give as a reward to the members of the first testing group in order to secure their cooperation?
- Which of the initial criteria for the external design formulated by the social scientist in behalf of this composite target-category, are considered valid by the prototyping team?
- What are the practices that actors engage in while using the CT, and what are the consequences thereof for previously existing practices? (See also guiding questions for the researcher in step 2.4.)
- Which new criteria for CT-design emerge?

Step 4: Introduction of the CT to the composite target-category as a whole

If the prototyping process is 'completed' and the results of the field test(s) have been satisfactorily incorporated into the internal and external design of the CT, the CT is ready to be put on offer to the wider target-category. That is to say, *if* the experiences obtained during the steps 3.1 and 3.2 are still promising. Due to the inherent connection between (the researchers') knowledge and ignorance, and the social nature of interventions, actor-oriented feasibility studies, prototyping and testing procedures, etc., all sorts of unintended and unexpected outcomes may have emerged during the whole process. Although the 'learning-oriented' method is designed in such a way that it has a potential to be flexible, and accommodate such outcomes and experiences, it may -not least since the actors involved may be less flexible- still prove impossible to introduce the CT successfully. Hence, even if one cannot look into the future, and if pressures favouring continuation will be rather high at this stage, there is sufficient reason to reflect once more on the feasibility and desirability of the whole idea.

Although the prototyping team can be dissolved at this point, it remains of crucial importance that the external design includes arrangements which secure the further integration of learning experiences when needed, which implies that arrangements for receiving regular feedback from the various actors involved need to be incorporated. If necessary, the programmers can -more or less 'behind the screen' and while maintaining the functionalities of the CT- change the software-technical philosophy on which the CT is based into a more 'elegant' solution. Similarly, it may -due to increased technological opportunities and practical experience- appear possible after a while to integrate the CT with other CT that had been originally developed for different purposes and/or composite target-categories.

Notes

1. Actors can strategically present themselves as indispensable to others, i.e. as an 'obligatory passage point' that other actors supposedly cannot avoid if they wish to realize certain goals (see Callon et al. (1986) and my discussion in section 6.3).

2. According to Leen Jacobse, the fl. 50,000.- should -in the view of CBT- have been spent on software development and advice. However, the growers in CAB were of the opinion that none of the growers would serve as Guinea-pigs if they first had to spend about fl. 1,000.- on hardware. Hence, they decided to ignore CBT in this respect. According to Leen Jacobse they were forgiven by CBT when the project appeared successful. Nevertheless, I will show later on that -with this absolution- this episode was not fully concluded.

3. The organizations of tree growers, bulb growers, mushroom growers and fruit growers, and the three Central Agricultural Organizations (i.e. the united farmers' unions) were involved as well. In 1988, NTS representatives occupied four positions (including the chair) in the SITU board which consisted of ten members (SITU, 1989).

4. The official name of the project is Enterprise Comparison within Study Clubs, sub-project Glasshouse Vegetables (Bedrijfsvergelijking in Studieclubverband, deelproject Glasgroenten).

5. In DICOTU commercial software and hardware developers with an interest in horticulture are united. According to INSP-LV agreements (see section 7.1) SITU was not supposed to engage in commercial activities, and NTS had similar -and even longer-standing- agreements with DICOTU.

6. Of these fl. 500,000.- about fl. 42,000.- was spent on 'project supervision by SITU', fl. 119,000.- was spent on 'supervision from study clubs in working groups', fl. 24,000.- was spend on 'hardware costs', and the remaining fl. 312,000.- was spent on the development and use of software. In all, the costs made on the central postal ERCS were about fl. 170,000.- (SITU, 1989:17).

7. Cooperation Coalition External Enterprise Comparison (Samenwerkingsverband Externe Bedrijfsvergelijking, SEB).

8. It seems that -in order to make GROEINET crop-independent, and provide growers with maximum flexibility and a maximum of registration parameters- its central database was designed in such a way that (to put it somewhat simplistically) each grower has access to a minimum of fields (one for the field name, and one for the field value), and a maximum of more than 2,000 records. Together with the fact that various calculated parameters are not stored in a calculated form, but need to be calculated each time that they are retrieved, this seems to cause delays in communication. In contrast, the central database of TELETUIN gives growers access to a minimum of 1 record per week and a maximum of about 300 fields which (on the basis of discussions with the study clubs at the beginning of each season) have a fixed field name per crop in the medium term, while calculated parameters are stored

permanently. Most study clubs using TELETUIN presently (1993) use about 200 fields. As at 1993 this seems to make TELETUIN less flexible and extensive than GROEINET, but also considerably faster in communication.

9. In section 6.3, I have introduced Callon et al.'s (1986) concept of 'enrolment', which in their view entails acquiring the legitimacy and/or ability to speak on behalf of (and/or with the support of) other actors. In this section, I will speak of 'enrolment' when it is clear that specific actors involve others in the realization of their projects, i.e. engage in a joint project in which (elements of) the respective actors' projects are incorporated. Thereby, I assume (partly on the basis of interview experience) that, at least in interactions between individual actors and relative outsiders (e.g. scientists), the individual actors tend to reinforce their individual projects by presenting them as joint projects; in that sense involving others in a joint project seems indeed to be connected with 'speaking on behalf of others'.

10. Apart from space considerations, this is related to the fact that I had to make an ex-post reconstruction of the respective CT-development histories.

11. Both Kaimowitz (1990), Röling & Engel (1990:13) and Engel & Seegers (1991) speak of 'external' pressures and/or factors which can enforce synergy in 'human activity systems' (see section 4.2). In my view the label 'external' is somewhat unfortunate in this context, since in order to have consequences such pressures must be internalized.

12. Clearly, the actors who write such documents are usually aware that they represent things in ways which bear little relevance to actual practice. Often they have various reasons to cover up certain matters, e.g. in order to secure funds, maintain space for manoeuvre, etc. In section 7.5, I have argued that such documents may be looked at as institutionalized forms of self-referentiality and/or intentional ignorance.

13. According to Vonk this uncertainty depends on: (a) the deducibility of the requirements from the tasks to be supported; (b) the knowledge and experience level of users and analysts; and (c) the risk of communication problems (Vonk, 1990:54).

14. I do not wish to imply that these steps should necessarily be taken in the order in which they are presented; certainly there must be iterations of various kinds, and several 'steps' can be taken simultaneously. Nevertheless, we feel that -at least at the mental level (as against the level of practical interventions)- there is a certain logical order of steps.

Part III

DISCUSSION AND CONCLUSIONS

Chapter 11

Theoretical and practical contributions

As a prerequisite for gaining a more adequate understanding of the use and development of CT, the central purpose of my theoretical exploration (chapters 3, 4 and 5) was: (a) to find a framework which allows us to understand communication technology mediated interactions in the context of a complex social setting in which a *variety* social actors are *actively* engaged, and (b) to identify conceptualizations which would help us to understand the social dimensions of knowledge, information, communication and rationality (see section 2.3). I have concluded preliminarily in section 5.3 that a constructivist interpretation of Giddens' theory of structuration seems more promising in this respect than other theoretical approaches.

Even if I have voiced my (partly empirically-based) predicaments and hesitations with respect to alternative approaches (e.g. the KIS perspective and/or Habermas' theory of communicative action) in the chapters 3, 4 and 5, strictly speaking I have not in this study attempted to 'prove' that my adapted version of Giddens' structuration theory is superior to other frameworks when it comes to understanding the use and development of CT in agriculture and horticulture. This is due to the simple fact that I have not rigorously pursued my empirical investigations with methodological tools and an empirical focus that derive from such competing perspectives. Instead, I have proposed in section 6.3 that my theoretical framework has important methodological consequences, and that the validity of the preliminary propositions could be explored by establishing the relevance of the methodological guidelines or empirical focus that can be logically derived from them. Only if this focus and these guidelines help to both increase our understanding of the use and development of communication technologies, *and* our capacity to make practical contributions would it be legitimate to conclude that (elements of) our theoretical framework are plausible and relevant.

In essence, the case-studies were conducted in conformity with the methodological guidelines formulated in section 6.3, even if the emphasis placed on different guidelines varied across the different chapters which constitute my empirical explorations[1]. Hence, I will discuss the extent to which the above mentioned understanding and capacities have been increased in the sections 11.1 and 11.2 respectively.

11.1 Contributions with respect to the theoretical understanding of the use and development of CT

Following the acceptance of a modified version of Giddens' theory of structuration, I have presented a coherent set of preliminary theoretical propositions for conceptualizing the use and development of CT (see section 6.1).

In a nutshell it was proposed that: (1) computer-based systems are best conceptualized as communication technologies; (2) communication processes must be looked at as politically and normatively-laden processes of negotiation; i.e. as processes in which action and knowledge are socially constructed; (3) through the use of CT actors wish to realize certain outcomes, projects and/or structural properties; thereby they draw on mutual knowledge (as inherently connected with mutual ignorance), which is the key modality of structure; (4) CT emerge at, constitute and/or (re)produce particular social interfaces; hence, their use must be understood in the context of the relations between various categories of users; (5) actors belonging to different epistemic communities may use CT in order to impose their views of 'reality' on others; (6) it is unhelpful to distinguish sharply between data, information and knowledge, for the distinction mystifies the socially constructed nature of what might better be termed knowledge constructs of various levels of concreteness and complexity; (7) the rules of interpretation that are under negotiation in a given context are important explanatory elements for the way in which CT are used; (8) for solving anticipation problems it can be very enlightening to know not only which types of anticipation problems exist, but also how they have come into being; thus, anticipation problems must be understood in their historical context; (9) actors can actively renegotiate 'structural characteristics' of CT; hence, the introduction of CT is likely to have unintended consequences; (10) CT have a potential to play a -never fully neutral- role in actors' reflexive monitoring of action.

At this point, I do not wish to discuss in retrospect the validity of each of these rather abstract propositions, for I want to avoid repeating the detailed theoretically oriented elaborations, analyses and conclusions that were presented in both Part I of this book, and in the concluding sections of the chapters that constitute Part II. Instead, I will reflect on the conclusions that I have -on the basis of my theoretical framework and its methodological implications- arrived at in relation the overall 'theoretical' problem statement. Subsequently, I will briefly recapitulate some key derivative theoretical conclusions in relation to the various fields of study covered in Part I.

Analyzing the social dimensions of anticipation problems

In my discussion of the KIS-perspective in section 4.2, I have argued that CT can fail to foresee (or anticipate): (a) the information needs and/or interpretative frameworks of farmers; (b) the practical procedures of problem solving that farmers and extension workers employ in their interactions; (c) the information that farmers (already) get through other sources; and/or (d) economic, material, political and cultural constraints and opportunities. In relation to this, I have in section 6.2, formulated the overall 'theoretical' problem statement which underlies this study as follows:

> To what extent do anticipation problems originate from: (a) the social nature of CT-development processes, and (b) insufficient recognition of the social dimensions of knowledge, information, rationality and communication among those that develop CT.

In chapter 7, I have outlined the broader context in which the use and development of agricultural CT needs to be looked at. In line with my theoretical framework, I have identified several structural properties which characterize this 'macro-context', and made plausible that these properties are (re)produced by actors in the domain of agro-informatics while drawing upon a web of common classifications (i.e. 'summary representations', 'rules of interpretations' or 'modalities of structure') in micro-situations. Thereby, I have shown that these classifications are historically rooted in particular (and often implicit) theoretical models, political convictions, interests, ideological positions and/or normative evaluations. Similarly, the mutual knowledge (according to my theoretical framework the key modality of structure) which is implied by this web of classifications, emerged as inherently associated with equally social areas of ignorance.

Throughout my empirical investigations, it has emerged that such mutual knowledge, areas of ignorance and the structural properties that emerge in relation to these can indeed result in anticipation problems. First, in chapter 8 my theoretical framework has led me to explore the use of DELAR in the context of strategic diversity in dairy farming. I have shown how, for example, the prevailing classification of farmers is indeed incorporated into DELAR in the sense that it is a highly unilinear, normative, complex and specialized package, which far from optimally anticipates diversity. Farmers adhering to different styles of farming appeared to attach different value and meaning to the various offerings of DELAR, while the significance of this phenomenon seemed to be insufficiently recognized in both its internal and external design. Since I was able to show that these differences need to be looked at in the context of different strategies vis-à-vis the social environment, it can indeed be concluded that the developers of DELAR have 'overlooked' the social dimensions of information, knowledge, and rationality.

In chapter 9, I have been able -in the context of diversity in enterprise registration and comparison practices among cucumber growers- to demonstrate the socially negotiated nature of knowledge, information, rationality and communication in much more detail. I have established that insufficient recognition of both diversity among cucumber growers with respect to enterprise registration and comparison practices, *and* the social dimensions thereof, can result in sub-optimal CT for supporting such practices. Finally, I have shown in chapter 10 that the development of CT (including their anticipatory characteristics) amounts to an inherently social process of negotiation, in which structural properties as identified in chapter 7 (e.g. resource distributions, organizational forms, 'obligatory passage points') can play a significant constraining and enabling role. Thereby, it appeared possible to describe and analyze such processes in terms of my theoretical framework.

In all, I have -especially in the chapters 8 and 9- demonstrated that insufficient recognition of the social dimensions of information, knowledge, communication and rationality can indeed cause a sub-optimal 'fit' between the internal and external design of a CT, and the social context in which it is supposed to be used. At the same time, I have -especially in the chapters 7 and 10- made plausible that such anticipatory 'misfits' are not so much the result of a naive ignorance on the side of the developers, but need to be looked at in the context of selections which they make in their (more or less discursive) efforts to pursue specific interests[2] and/or (re)produce particular structural properties. Thus, I can conclude that the two potential 'causes' for anticipation problems mentioned in the overall problem statement do indeed play a role, and are highly interrelated as well.

Types of anticipatory 'misfits' and their consequences
A more refined typology of anticipatory misfits than the one presented earlier, can be extracted from my elaborations in section 7.3. In the context of making a classification of CT on the basis of my 'communication paradigm', I identified a variety of models which - depending on the type of CT- are usually to a greater or lesser extent (and often implicitly) incorporated into CT. When the models incorporated in the external and internal design of a particular CT somehow conflict with the models that (on the bases of negotiations between the actors involved) are drawn upon in their context of application (i.e. they are 'resisted'), we can speak of (corresponding types of) anticipatory 'misfits' (see box 11.1).

Box 11.1: **Models underlying CT and their corresponding types of anticipatory 'misfits'**
I propose to distinguish between (politically and/or normatively laden) anticipatory misfits in terms of:

- models of human learning;
- models of the user, such as:
  . models of (future) information needs;
  . models of foreknowledge and support needed;
  . models of decision making and rationality;
- models of natural and technical processes, opportunities and constraints;
- models of socio-economic processes, opportunities and constraints;
- models of advisory/extension processes;
- models of communication patterns.

In the case-studies presented, one can find examples of anticipation problems with respect to all the models mentioned. Thereby I have drawn particular attention to insufficient recognition of diversity among users; i.e. the various 'models of the user' which are implemented are of a too general nature. Apart from the consequences of diversity with respect to 'models of decision making and rationality', I think that my case-studies indicate that -in general- such models are conceptualized inadequately by agro-informaticians. While agro-informaticians (and many others) frequently stress the importance of information (and CT) for *decision making*, and conceptualize decision making as an individual and (preferably) formally rational process which occurs at a discrete moment in time, my case-studies seem to indicate that the offerings provided by CT play a role in continuous, chaotic, inherently social and often routine-like process of *learning*. In Giddens' terms, one could argue that CT tend to be sub-optimally designed for supporting the continuous process of 'reflexive monitoring of action' (see section 5.3). This assessment seems to be compatible as well with Winograd & Flores' (1986:144) conclusion that managers are not so much involved with decision making, but rather with the generation and maintenance of a network of conversations for action (see section 3.3).

When looking at 'anticipation' in the widest possible sense, it can indeed be argued that -in retrospect- a limited adoption of CT (relative to the target-category for which it was intended) is always the result of anticipatory 'misfits', for it will always be possible to attribute this either to a sub-optimal internal design (e.g. in terms of parameters included, organization of the user-interface, concepts used in searching facilities, speed of operation, modelling of natural, technical or economic processes, built-in rationality, etc.) and/or to an inadequate external design (e.g. in terms of arrangements for securing flexibility, development procedures, organization of supervision, marketing strategies, costs associated with use, the social dimensions and/or structural properties connected with the context in which it is to be used, etc.).

At the same time, it is not possible to predict straightforwardly that built-in anticipatory 'misfits' result necessarily in a limited adoption, at least not if we (rather narrowly) define 'adoption' in terms of the actual possession of the CT. First, a 'perfect' CT which totally suits the variety of users that it was intended for does not exist, and I have shown in both chapters 8 and 9 that users are quite able to -at least temporarily- cope with and/or correct for particular shortcomings. Second, anticipatory 'misfits' (e.g. lack of flexibility) frequently come to the fore only when users gain experience with a CT, i.e. a CT may increasingly become and/or appear sub-optimal *after* it has been adopted. Third, it has emerged in chapters 7, 8 and 9, that adoption of CT is a social process as well. That is, adoption may have to be looked at in the context of: (a) convictions that -in the long run- one will not be able to survive as a farmer without CT; (b) ambitions to be identified as 'progressive' or as 'a survivor'; (c) efforts to get access to special services or subsidies offered by CT-suppliers; (d) the free provision of CT by suppliers in order to tie customers; (e) attempts to maintain good relations with an extension worker; (f) endeavours to secure access to particular colleagues or discourses; and/or (g) arrangements which effectively enforce the use of CT.

More so than the simple possession of (or access to) CT, however, anticipatory 'misfits' are likely to affect the duration, quality and/or nature of use. With respect to the latter, it is useful to note that CT may well generate forms of use which were not foreseen at the time of their initial introduction and adoption. Thus, the question *to what extent* anticipatory 'misfits' will eventually prevent widespread adoption of a CT can only be sensibly addressed in a contextual manner.

Key derivative conclusions for different fields of study

The preliminary theoretical propositions which were presented in section 6.1 are of a fairly abstract nature, and -in principle- were expected to have relevance to all the different fields of study that I have discussed in my theoretical explorations. Below, I will draw attention to some less abstract theoretical conclusions. These conclusions were derived while exploring in greater detail the consequences of my theoretical framework with respect to more specific issues raised within these fields of study.

Informatics and information systems research

In relation to the domains of informatics and information systems research (see chapter 3), my case-studies support several conclusions. First, it has become clear that there are fundamental differences between communication within and/or between computers, and communication between human actors which are mediated by software and hardware packages. Second, it has emerged throughout my empirical investigations that the use of CT cannot be understood only in terms of a more or less adequate internal design (including a software-technical 'user-interface'), but needs to be looked at in the context of an often implicit external design (see section 7.3). In essence, this means that CT have a 'societal code' and often emerge at, constitute and (re)produce particular social interfaces (Long, 1989). Third, I have argued in section 7.3, that the division between 'structured' and 'unstructured' problems (Gorry & Scott Morton, 1971) is theoretically undesirable, and therefore current classifications of CT seem less informative. Thus, I have attempted to develop a classification which is more in line with my theoretical framework, i.e. my 'communication paradigm'.

Fourth, I have concluded in section 9.8, that deductive approaches towards the identification of information needs should at least be complemented with more inductive methods, which include qualitative interviews with the different categories of users. In contrast to assumptions made by Davis & Olson (1985), the employment of such methods is a highly skilled activity which is especially suited for 'high uncertainty' situations. Fifth, the explorations in chapter 10 suggest that we need to develop a 'learning-oriented' method towards CT-development in agriculture, and that many of the presently used CT-development methods and procedures in agro-informatics obstruct rather than stimulate the rapid integration of learning experiences in CT-design. Sixth, I have argued in section 10.6, that an adequate 'learning-oriented' CT-development method may need to incorporate both methods that originate from actor-oriented sociology, extension science and prototyping approaches in information systems research.

Seventh, I have concluded in section 8.6, that -in contrast to the prevailing policies- the prospects of developing valid agricultural CT which include highly complex and 'integral' models, are limited. Finally, it has emerged that as the complexity of a CT increases, the anticipation of diversity and the integration of knowledge from different epistemic communities becomes increasingly dependent on adequate organizational arrangements in the external design.

Computer mediated communications in organizations

My explorations lead me to draw various conclusions with respect to issues that are raised within different branches of communication science (see chapter 4). In relation to efforts to explain media use and adoption in the field of computer mediated communications in organizations (see section 4.1) these are the following. First, I have shown throughout my explorations that CT do not only have 'media characteristics' or features in the *technical* sense, but that -in a particular context- they have various types of *social* 'characteristics' as well. That is, they incorporate social models, codes and organizational arrangements which form an important element in explaining the use of such media, and which are nevertheless overlooked by the great majority of theoretical approaches in this domain. Second, it has emerged in chapter 10 especially, that such 'characteristics' cannot be treated as objectively given. Not only is the perception of such characteristics subject to social influence (see also Fulk et al., 1990), but these characteristics themselves are actively negotiated through time, and the events that occur during this historical process tend to have repercussions with respect to media use as well. Together, these two conclusions imply a third, which is that a CT which incorporates a particular internal design, can still exhibit rather different 'characteristics' when applied in different social contexts.

Fourth, it emerges that what is or is not a 'critical mass' of users, needs to be looked at in a contextual manner. My elaborations in chapter 9 suggest that a very small percentage of actors in a particular context may in fact constitute a critical mass. Fifth, while Markus (1990:204) argues that in general CT tend to have an 'accelerating production function', whereby later adopters tend to have progressively higher returns on their investments than earlier ones (see section 4.1), it could be argued that in the context of enterprise comparisons in horticulture (see chapter 9), an orchestrated adoption by a small group of growers temporarily (that is, until others have adopted as well) results in high returns in terms of opportunities to favourably influence group composition (i.e. in a 'decelerating production function'). Thus, it seems that CT do not necessarily have *one* 'production function', but several ones, which express different interests associated with a particular technology, and which may be differently distributed over various (categories of) users.

Sixth, with respect to the issue of finding an appropriate unit of analysis for studying media use, my study suggests that we may fruitfully supplement a focus on either individuals (with or without socially influenced perceptions; see Fulk et al., 1990 and Trevino et al., 1990 respectively), or networks and their characteristics (Contractor & Eisenberg, 1990), with a focus on historically constituted social actors and the networks of interaction that they (have) engage(d) in. That is, I propose to look at CT-mediated interactions between actors in the context of interactions that these actors more or less simultaneously engage in, and/or have engaged in in the past. Seventh, I am of the opinion that my adapted version of Giddens' theory of structuration -in contrast to the interpretation of Giddens' theory by Contractor & Eisenberg (1990) (see section 4.1)- provides a theory of communication which indeed elaborates upon the interrelations between communication, meaning, power, social structure, etc. Rather surprisingly, it seems that such a theory has so far been lacking in this branch of communication science. Finally, this framework offers us the opportunity to -more radically than Contractor & Eisenberg (1990)- break away from linear and/or sequential conceptualizations of recursiveness and causality, and develop more cyclical and/or simultaneous conceptualizations instead.

Extension science

A first set of conclusions that can be drawn with respect to more specific issues raised within extension science, relates to the role of extension workers. First, I have concluded in sections 8.6 and 9.8, that in interactions with farmers extension workers are best conceptualized as actors who bring in a different (rather than a different level of) expertise and analytical capacity. Thereby, and in line with my earlier criticism towards current conceptualizations of (rational) decision making, it has emerged that extension workers can play a significant role in the facilitation of *learning* processes among farmers. Second, it has emerged in section 10.4, that extension workers can also play an important intermediary (and again learning-facilitating) role in processes of CT-development. Third, I wish to emphasize that learning processes (and thereby learning-facilitating activities) are inherently social in nature (see especially sections 9.4 and 10.5). My conceptualization of knowledge as the key modality of structure implies, in fact, that learning is inherently connected with structural change, and is therefore far from neutral. In relation to this, Giddens' theory urges me to -at a more abstract level- reconceptualize the role of extension workers (and professional communicators in general) in processes of social change. In many cases such actors are actively involved in putting forward particular 'new' rules of interpretation with regard to, for example, the theoretical understanding of the natural and social world, unintended consequences of action, unacknowledged conditions of action, etc. To the extent that such rules of interpretation originate from social scientists, it can be argued that professional communicators aim at capitalizing on the 'double hermeneutic' of the social sciences (see section 5.3). Thus, we should not look at extension as having a *neutral* facilitating function for developing higher quality collective agency (as is the case in the KIS perspective), or as an attempt to persuade individuals to change and/or adopt particular behaviours on the basis of rational argumentation (as is implicit in the PI perspective). Given the close interconnections between social structure, knowledge and power, I would propose to look at extension activities as active and inherently political communicative interventions by which professional communicators aim at the (re)production of particular outcomes and/or structural properties in society.

Fourth, in relation to intervention in general it must -in line with criticisms formulated by rural development sociologists (Long & Van der Ploeg, 1989)- be noted that, since such interventions take place in complex social settings in which other actors are actively engaged as well, the consequences of such interventions are inherently characterized by a considerable degree of unpredictability (see section 10.5). This assessment seems to run counter to the assumptions which underlie planned approaches towards communicative intervention (Van Woerkum, 1987b; Wapenaar et al., 1989), and for that matter to planned approaches towards development (Van Dusseldorp, 1990) and CT-development (see section 7.4). It could be argued that planning approaches are in fact developed in order to reduce unpredictability, but there are indications that formal planning procedures can easily obstruct rather than stimulate the realization of particular outcomes, since such procedures may hinder effective integration of learning experiences (see section 10.5) and/or enhance organized ignorance and self-referentiality (see section 7.5).

Fifth, I have concluded in section 10.5, that the prospects of developing effective collective agency with the help of approaches which aim at securing negotiated consensus among various actors (such as soft systems methodologies, see sections 3.3 and 4.2) are highly dependent on the selection of actors that are included in the negotiations at a given time and space setting (i.e. on where the boundaries of 'the system' are drawn). In fact, my observations in chapter 10 suggest that the 'creation' of a conflict between 'insiders' and 'outsiders' may -at least in certain respects- be quite productive.

Sixth, I have stressed the importance of conducting user-research (see sections 9.8 and 10.6). In relation to this, I have concluded that current approaches towards the identification of 'homogeneous target-categories' are far too simplistic, and that interventionists would do better exploring a variety of practice-based classifications of actors within a particular community, which are specific to a unique intervention context, and on the basis of this establish an appropriate level of diversity for developing a 'standard' intervention (see sections 8.6 and 9.8).

Finally, my explorations suggest that communicative interventions do always take place in a multi-actor context, and that therefore extension science has much to benefit from sociological conceptualizations of key-notions such as knowledge, information, rationality and communication.

The (agrarian) sociology of rural development
Finally, my explorations lead to several conclusions in relation to important issues within the (agrarian) sociology of rural development. First, I have reinforced my earlier conclusion that -if we reject the assumption that there is somehow a fundamental difference between 'scientific' knowledge and 'non-scientific' knowledge- it is unhelpful to make a fundamental distinction between 'l'art de la localité' and scientific knowledge (see section 5.1. for details), whereby it would somehow be inherently impossible to incorporate the former in a CT in a similar way as the latter (Frouws & Van der Ploeg, 1988:30, 54). As Van der Ploeg recognizes (1987:125), there is a paradox in the sense that developers of scientific knowledge (or -as I have argued in section 5.1- scientists' 'l'art de la localité') frequently assume that they can make farmers' 'l'art de la localité' redundant, while at the same time the introduction of such knowledge reactivates the development of new 'l'art de la localité' on the side of farmers. My brief elaboration of the consequences of the introduction of climate computers for growers' discourse and practices (see section 9.8) clearly illustrates this paradox, but the case-study presented in chapter 9 also shows how -in the process of becoming more closely intertwined- *both* scientists' and growers' knowledge constructs can be incorporated simultaneously into one CT.

Second, I have shown in chapter 9 especially, that -in order to arrive at concrete practical contributions- it can be important to generate a variety of *contextual* practice-based classifications of farmers and/or horticulturists. This implies that the relevance of a particular (dimension for) classification (for example a fixed classification into 'styles of farming' or 'adoption categories' along dimensions such as 'orientation towards the market' and/or 'orientation towards technology') is likely to differ from context to context.

Third, I am of the opinion that by identifying knowledge as the key-modality of structure, and emphasizing its historical and spatial nature, I have developed an actor-oriented conceptualization of structure which -when compared with Long & Van der Ploeg's (1991) conceptualizations (see section 5.1)- offers a greater potential for understanding the way in which actors are not only enabled, but also *constrained* by social structures. Finally, my reflections on the role of the actor-oriented social scientist in processes of social change (see sections 8.6 and 9.8) has helped me to proceed on the path of developing an (long awaited and Long awaited) actor-oriented approach for arriving at more concrete practical contributions than those that -in a rather undirected manner- derive from the 'double hermeneutics' of social science (see section 10.6).

11.2 Recommendations for practitioners

In this section, I will translate both the theoretical conclusions and the practical insights arrived at in the sections 8.6, 9.8, 10.5 and 10.6, into a set of recommendations for practitioners. These recommendations will be ordered again according to the five practical contributions that I envisaged to make by means of my study.

On developing relevant empirically-based classifications of farmers and horticulturists (part 3)

When developing a CT for farmers or horticulturists it is important to acknowledge that it will have to cater for the needs of a rather diverse audience. For the development of appropriate CT, it is imperative to get some grip on this diversity, since the various sub-audiences are likely to make different demands on the prospective CT, which may be hard to combine within one and the same CT. Although making a classification of farmers can be useful for defining a target-category with an appropriate level of diversity, many currently used classifications (and methods for making them) are likely to be of limited and/or sub-optimal use. Many of these classifications (e.g. those along lines of adoption speed, farm size, age, (sub)branch, crop, general orientation towards technology and/or market, etc.) are used to cut across different contexts, and do not necessarily provide the sharpest possible insight into the relevant diversity connected with the contexts for which a specific CT is developed.

Therefore, practitioners are recommended to explore and observe (in a particular context) the day-to-day practices that prospective users engage in, identify relevant knowledge-related practices and diversity therein, and generate a *variety* of classifications of users in relation to these (recommendation 1). Such contextual and 'temporary' classifications, then, should be used for guiding further user-research efforts, in which a central theme is *why* these practices take place as they do, and not in other forms or locations (recommendation 2). In cases were the prospective users are not only farmers or horticulturists but also others (e.g. information suppliers, extension workers, etc.) practitioners are advised to extend their practice-based analysis of diversity to these actors as well (recommendation 3). (For further details see step 2.2 to 2.7 in section 10.6.).

Design-criteria for facilitating integration of knowledge from different epistemic communities (part 3)

In many cases, the use of CT implies a (more or less direct) communication process between actors that belong to different epistemic communities (see section 6.1). Thus, for such a CT to be useful, provisions must be made that an integration or fusion between different perspectives is facilitated. My study indicates that, in general, such an integration takes place in a continuous process of *learning*. In relation to this, several recommendations can be formulated.

First, I would suggest that practitioners orient themselves towards developing CT that support *learning* in a specific domain, rather than developing CT that aim at supporting specific *decisions* (recommendation 4). The former type of system can be expected to remain of interest over a prolonged period and to bear more relevance to the day-to-day practice of farm management than the latter. Furthermore, in order to support learning and reduce 'blindness' (Winograd & Flores, 1986), CT should be transparent; that is, it must be easy to gain an insight into the models and calculation rules that underlie a particular CT (recommendation 5). This fifth recommendation leads to the sixth, which is that it is of limited use to develop highly complex CT (recommendation 6). Not only do highly complex CT usually obstruct the opportunity to gain insight and take decisions in a well-informed manner, but also they often inadequately anticipate diversity. That is, from the perspective of individual farmers they tend to suffer from a considerable multiplication of errors. In any case, I would formulate as a rule of thumb that as the complexity of a CT increases (in terms of the models incorporated into its internal design), practitioners must pay more attention to making adequate organizational arrangements (i.e. aspects of its external design) that support the integration of knowledge from different epistemic communities (recommendation 7). My study indicates that the provision of opportunities for open-minded and context-sensitive discussion within and between epistemic communities (e.g. in study clubs) may well be an effective element in such an external design. Thus, practitioners are recommended to stimulate and support the formation of such platforms around CT (recommendation 8). In relation to the anticipation of diversity, I must also dissuade practitioners from developing CT with a highly normative nature (recommendation 9).

Preferably, a CT should -in order to facilitate learning over a prolonged period of time- not only have an internal design that is transparent and simple, but also be easily adaptable over time (recommendation 10). In fact, recommendations 5 and 6 can be seen as preconditions for recommendation 10, for only if the former are met is it possible to incorporate rapidly new insights, parameters, facilities, etc. Clearly, such flexibility has implications for the external design as well, in that adequate resources and monitoring and decision-making infrastructures must be provided that guarantee rapid identification of new learning opportunities, and the implementation of these in CT (recommendation 11). An additional suggestion for the internal design of CT is that it might include opportunities for farmers or horticulturists to 'play around' with their own or others' registration material, for example, by offering opportunities for selection, graphical representation, projection, etc. (recommendation 12).

Finally, in relation to the integration of knowledge from different epistemic communities, it can be argued that practitioners would do wise not to get too obsessed with the standardization of calculation rules, etc., across different CT (recommendation 13). Although in the context of farm comparison activities such standardization has a value for farmers, extension workers and researchers, this value must not be exaggerated. Even if calculated with the help of standard definitions and measurement procedures, the meaning of such parameters remains ambiguous for they can only be interpreted adequately when placed in their appropriate historical/situational context. Especially when prescriptive in nature, the enforcement of standard calculation rules may not do justice to existing diversity as well. Moreover, early enforcement of standardization may hamper processes of innovation.

The potential contribution of (and to) extension workers (part 3)

In relation to the role that extension may play in relation to the use of CT, I have only focused on the role they can play in dealing with CT-generated outputs rather than on their potential role in providing farmers with advice about CT and/or in helping them to learn how to use such technologies. In this context, I have argued earlier that in their interactions with farmers, extension workers bring in a different (rather than a different level of) expertise and analytical capacity. This assessment has repercussions for the way in which extension workers can -with or without the help of CT- expect to effectively give specific advice and/or facilitate learning.

Although it is vital that extension workers remain critical towards farmers' strategies and convictions, it is important that -in the end- extension workers value a particular farm on its own merits, and give adequate advice in the context of the strategies and principles that farmers wish to adhere to (recommendation 14).

As implied in recommendation 8, extension workers are advised to stimulate and support the formation of discussion platforms around complex CT. In order to capitalize on the potential of such platforms, extension workers do wise to develop techniques that help to access the participants' knowledge and experience (recommendation 15). Despite the fact that the potential of CT to provide an agenda for discussion is one of their greatest contributions to both farmers and extension workers, I must dissuade extension workers from using CT-generated results as a *rigid* agenda (recommendation 16).

Although in this book I have not presented case-studies on complex CT that generate specific advice, my experiences in relation to such systems indicate that their greatest contribution also lies in the fact that they help to put issues on the agenda, and not so much in the fact that they produce specific advice. In these cases, however, such an agenda is often more directively imposed by the CT. In relation to this, I recommend that extension workers be critical towards such systems, and only use them if they provide either a high quality agenda or -in connection with this- the calculation of relevant parameters that would otherwise require a lot of manual labour (recommendation 17). In any case, extension workers would do wise to adapt CT-generated advice according to their own insight, i.e. remain responsible for the advice given (recommendation 18).

Finally, I would suggest that extension workers can legitimately claim that they may successfully act as intermediaries between farmers and CT-developers in CT-development processes. Thus, I would recommend that CT-developers enrol extension workers for these purposes (recommendation 19).

Towards an inductive methodology for identifying information needs (part 2)

I have shown in Part II of this book that, as a matter of day-to-day routine, farmers actively record and/or keep in touch with information from a variety of sources. Both the tangibility of these sources, and the extent to which farmers are discursively aware of these monitoring activities differ. Moreover, farmers are frequently confronted with non-routine-like situations. In order to deal with such situations, they make their analyses on the basis of already available information and registration material, and search for additional inputs as well. For the identification of information needs that are to be incorporated into a CT, this situation poses certain difficulties. On the one hand, it is rather difficult for anyone to predict the problematic situations that farmers will experience in the future (let alone the specific questions that must be addressed at such a point), and on the other hand, farmers are often not discursively aware of the needs that are already fulfilled (precisely because they are already catered for), and find it difficult to assess the (added) value of information and technological opportunities that they have no experience with. Moreover, information needs are diverse, and in many cases subject to rapid change.

Although perhaps tempting, it is of limited use to respond to these difficulties by deducing information needs from rational decision-making models, scientific models, etc. Rather than taking a normative stance, I think it is wise to take as a starting point, that decision making and problem solving are fairly chaotic phenomena, and constitute a continuous, more or less gradual process of learning (recommendation 19). In order to develop adequate CT that support these processes, then, it seems important to explore empirically how such processes evolve in day-to-day practice. That is, I recommend the use of inductive methods, whereby primacy is given to participant observation and qualitative interviews (recommendation 20).

In the context of both the observation that information needs are diverse and subject to change, and my earlier recommendation that CT must be easily adaptable over time, the focus in the above mentioned explorations must be on *knowledge and information-related practices* and associated *types of information needs* rather than on *specific* information needs (recommendation 21). In my case-studies it has, for example, emerged that: (a) farmers learn through making various types of comparisons; (b) that these comparisons relate to either strategic or operational issues; (c) that such diverging themes require different types of parameters and graphical facilities; (d) that in relation to distinct themes and modes of comparison dissimilar kinds of context information are required; and (e) that sometimes a CT is used for analyzing concrete problems, and that in other cases they are merely used for inventing problems, etc. It is for these and many other regularly occurring practices that *tools* can be provided; some of these (but certainly not all of them) may sensibly be CT.

In relation to these practices, empirical studies must not only focus on identifying relevant types of information needs, but also on identifying wider criteria which a CT aimed at supporting such practices might have to meet (recommendation 22). In the next section, I will elaborate from a slightly different angle on what an inductive methodology for arriving at an adequate CT-design might entail.

User-research, user-participation (part 2), and the social scientists' contribution (part 4)

Earlier in this book I have proposed that user-participation and user-research can be incorporated into what I have labelled a 'learning-oriented' method for CT-design. Roughly speaking, the method consists of four steps: (1) the generation of an initial idea; (2) an actor-oriented study of feasibility and desirability; (3) prototyping and field testing; and (4) introduction of the CT to the composite target-category. The details of this method, and especially the social scientists' contribution to it, are spelt out in section 10.6. In this section, I will outline some key recommendations that are implied by it.

The learning-oriented method for CT-design is recommended especially in the early stages of innovation processes; that is, if little experience exists with respect to how the CT might contribute to particular domains of activity (recommendation 23). The method sets out to test the feasibility and desirability of immature ideas, and to further develop them into a concrete CT when appropriate. Hence, it proposes that the ideas that are to be explored should preferably originate from the perceived beneficiaries themselves (recommendation 24). Furthermore, the method assumes that, in addition to software-developers, extension workers and perceived beneficiaries, social scientists and/or practitioners with a social scientific background can play an important role in CT-development processes. That is, CT-developers are advised to enrol the latter in order to conduct user-research within such processes at the earliest possible stage (recommendation 25).

In principle, social scientists can be especially useful in: (a) coming to grips with both diversity and the social context in which a CT is to be used; (b) the formulation of initial criteria for CT-design; and -in connection with all this- (c) preventing different types of anticipatory misfits and the overall failure of CT-development efforts. In order to ensure that this potential materializes, CT-developers would do wise to employ social scientists who have a critical outlook and a preference for qualitative research methods (recommendation 26).

User-influence can best be organized by asking the perceived beneficiaries to participate in a prototyping process. Thereby, a great deal of attention must be paid to the selection of participants; that is, the results of earlier conducted user-research must be taken into account when composing a prototyping team (recommendation 27). Later on, a different group of users can be asked to participate in field tests. Such field testing must go beyond testing the technical performance of the CT, and should preferably take place under field conditions (recommendations 28).

During CT-development processes, all actors involved should be stimulated to reflect critically on the theoretical, political, normative and ideological implications of their activities and choices. That is, they should be encouraged to make explicit: (a) on the basis of which assumptions, normative considerations and beliefs choices are made; (b) what and whose interests these choices are likely to serve; (c) what consequences these built-in 'codes' are likely to have for the use of the prospective CT; and (d) whether or not these consequences are desirable (recommendation 29).

Finally, CT-developers are advised to situate a learning-oriented CT-development process in an organizational setting in which: (a) communication lines are short; (b) decisions can be taken rapidly; (c) actors are prepared to work quickly and cheaply; (d) access exists to sufficient software and hardware resources and experiences; (e) the development process can be -at least temporarily- shielded from external conditions, interventions and/or formal planning.

3.3 Final conclusion

Even if I have at several points in this thesis suggested that it is unhelpful to evaluate the outcomes of CT-development projects only against the background of goals and criteria that were formulated at the outset, I feel compelled to evaluate the outcomes of the explorations presented in this book on the basis of the criteria formulated earlier in chapter 6. In this respect, I think that scientists -at least when the aim is to write a coherent book- should obey different rules than project managers. The price that needs to be paid in order to achieve coherence, is perhaps a certain amount of autopoietic reasoning; after all Gödel (1962) has already shown that -even within mathematics- it is impossible in its own terms to 'prove' the external validity of a set of coherent propositions. Thus, I will conclude by establishing the plausibility of my theoretical framework on the basis of the extent to which pursuing the methodological guidelines and empirical focus that followed logically from it, has improved: (a) our understanding of the use and development of communication technologies, and (b) our capacity to practically contribute to the development of adequate CT.

Indeed I have argued in section 11.1, that my empirical explorations have helped to generate answers to the 'theoretical' problem statement. It has become plausible that a lack of correspondence between, on the one hand, the various models that are (more or less implicitly) incorporated in CT-design, and on the other, the models that are actually drawn upon in the context in which such CT are supposed to be used, indeed reflect both the social nature of CT-development processes, and insufficient recognition of the social dimensions of knowledge, information, rationality and communication among those that develop CT. More specifically, it is insufficiently acknowledged that the construction of knowledge and information in communication processes is inherently connected with the (re)production of particular structural properties, and therefore associated with normative and political struggle. Also, I have shown that this 'lack of recognition' is by no means accidental or naive, but is itself connected with efforts to (re)produce particular structural properties as well. The extent to which the occurrence of anticipatory 'misfits' explains the limited adoption of CT in agriculture depends on how widely one defines the concepts of 'anticipation' and 'adoption'. In the widest possible meaning of the concepts, the question becomes in fact tautological, and therefore useless. When defined more narrowly, the question can only be addressed in a contextual manner; i.e. one cannot draw a straight line between the occurrence of anticipatory 'misfits' and adoption, since adoption is a social process as well.

Apart from providing insight in relation to the 'theoretical' problem statement, my empirical explorations have helped expose weaknesses in theoretical frameworks which are frequently adopted by agro-informaticians, communication scientists, extension scientists and rural development sociologists. It appeared possible to reformulate and/or problematize a variety of both rather abstract and much more 'mundane' issues in a rather wide variety of scientific fields of study. New answers to these issues have in some cases been provided as well.

My empirical explorations have also led me to draw various practical conclusions (see sections 8.6, 9.8, 10.5 and 10.6), which range from concrete recommendations and design-criteria for improving a particular CT, to more general recommendations, rules of thumb and methods for practitioners. In this latter category, the explorations have inspired the formulation of a 'learning-oriented' method of CT-development (see section 10.6). This method is not so much aimed at realizing particular predefined *goals* by means of formal planning, but rather to test the feasibility and desirability of immature *ideas*, and adapt these if necessary. To this end, the method is designed as an open-ended procedure in which both interveners, social scientists and various categories of prospective beneficiaries have different learning responsibilities. In relation to Winograd & Flores' (1986:53) assessment that the "most successful designs are not those that try to fully model the domain in which they operate, but those that are 'in alignment' with the fundamental structure of that domain, and that allow for modification and evolution to generate new structural coupling" (see also section 3.3), it can be argued that the 'learning-oriented' method provides a tool for developing such systems.

Due to the fact that -regardless of the method adopted- CT-development interventions will always remain a social process, the outcomes of such interventions will always be characterized by a considerable degree of unpredictability. Thus, applying the 'learning-oriented' method is certainly not a guarantee for successful CT-development. Nevertheless, I am confident that the approach helps to alleviate some of the problems associated with frequently used CT-development methods in agriculture. Most notably, the use of the 'learning-oriented' method can be expected to: (a) correct for the often limited capacity of presently used methods to quickly incorporate learning experiences; (b) help to identify a target-category with an adequate level of diversity for which it is plausible to expect that an overarching CT can be realistically developed; and (c) generate design-criteria which allow for the construction of a first prototype with relatively high anticipatory qualities.

In all, the understanding of the use and development of CT has indeed been altered on the basis of my theoretical framework. That is, the repertoire of *plausible* explanations has expanded, which means that ignorance may have been reduced, i.e. that opportunities for understanding have been improved. Similarly, the explorations on the basis of this framework have led to the formulation of concrete practical recommendations, and the generation of a method to arrive at such directions in the future. Thus, I can conclude that a constructivist actor-oriented 'communication paradigm' constitutes an attractive perspective for both understanding and improving CT-development interventions in agriculture and horticulture.

Notes

1. The emphasis placed on different methodological guidelines did not only alter as a result of my own learning process (as was the case with the differential efforts made to observe day-to-day practices in the chapters 8 and 9 respectively), but also according to the nature of the study. In the historical studies presented in chapter 10, for example, it seemed much more feasible to analyze unintended consequences of action and unacknowledged conditions for action than in earlier chapters. Similarly, the notion of summary representations proved particularly useful for analyzing the broader context on the basis of written artefacts (chapter 7), while the concepts proposed by Callon et al. (1986) served as useful sensitizing concepts while reconstructing the development histories in chapter 10.
Throughout my empirical explorations (and especially in those chapters where case-studies were presented), however, there has been considerable attention to: (a) (differential) practices; (b) the social, historical and spatial context in which they take place; (c) diverging strategies, intentions, projects, interpretations and rationalizations; (d) actors' capacity to create space for manoeuvre. Moreover, all case-studies were aimed at exploring social action in interface situations. Finally, I have attempted to remain agnostic towards the actions, practices and rationalizations of different actors.

2. That is, the design of a particular CT can often be understood in the context of the developers' strategic considerations, such as: (a) a wish to tie customers; (b) an aspiration to create, maintain and/or reinforce an 'expert' versus 'layman' relationship; (c) a need to show the practical relevance of research models; (d) an ambition to increase the scope for Integrated Chain Management in the agricultural production chain; (e) an attempt to impose normative models of decision making, rationality, reality and/or farm development; (f) a wish to show that one is not lagging behind in applying certain techniques and technologies; and/or (g) a need to meet Ministerial criteria for funding, etc. (see chapters 7 and 10).

Appendix 1 (part 1): Average 1986/1987 DELAR results per style of farming in terms of parameters for which no norms were calculated or available to the researcher. In relation to all tables, analysis of variance tests, comparing the means of the 'dependent' variables for the categorization variable, were carried out. In each test, a DUNCAN procedure was used to identify pairs of groups that have significantly different means at the α=0.05 level.

	TOTAL (n=104)	multiple goalers (G) (n=10)	thrifty farmers (T) (n=13)	practical farmers (P) (n=24)	cowmen (C) (n=34)	machine-men (M) (n=7)	fanatical farmers (F) (n=16)	F, p, and pairs which differ at α=0.05
Kilograms Nitrogen per hectare of pasture	402	369	401	391	420	397	405	F=0.54
minimum	159	166	288	211	159	343	277	p=0.72
maximum	733	552	607	600	733	441	575	
Number of milking cows per hectare	2.70	2.61	2.49	2.89	2.65	2.98	2.61	F=1.26
minimum	1.60	1.85	1.89	2.03	1.60	1.93	1.69	p=0.29
maximum	4.53	3.67	3.30	4.53	4.21	3.98	3.91	
Cost on milk products per calf (fl.)	83.9	94.2	76.1	78.6	76.9	97.4	100.7	F=0.45
minimum	26	56	26	37	33	32	40	p=0.81
maximum	630	152	125	194	201	267	630	
Average age at first calving (years)	2.21	2.24	2.27	2.21	2.20	2.24	2.20	F=2.48
minimum	2.13	2.13	2.13	2.13	2.13	2.13	2.13	p=0.037
maximum	2.28	2.28	2.28	2.28	2.28	2.28	2.28	T vs F;C;P
Percentage of calves born (relative to number of milking cows)	111.6	116.3	113.8	112.4	111.1	110.7	106.8	F=1.17 p=0.33
minimum	88	91	97	89	90	94	88	
maximum	132	131	124	130	132	126	122	
calf mortality (%) in first 14 months	7.2	7.1	6.7	7.8	6.2	8.4	8.4	F=1.09
minimum	1	1	2	2	2	5	3	p=0.37
maximum	19	19	14	14	14	15	13	
Expulsion percentage for milking cows	40.3	36.6	38.9	41.4	43.2	41.6	35.5	F=1.35
minimum	14	21	24	21	26	27	14	p=0.24
maximum	79	58	62	79	79	63	57	

Appendix 1 (part 1, continued): Average 1986/1987 DELAR results per style of farming in terms of parameters for which no norms were calculated and/or available to the researcher.

	TOTAL (n=104)	multiple goalers (G) (n=10)	thrifty farmers (T) (n=13)	practical farmers (P) (n=24)	cowmen (C) (n=34)	machine-men (M) (n=7)	fanatical farmers (F) (n=16)	F, p, and pairs which differ at $\alpha=0.05$
Percentage of milking cows replaced	32.9 7 66	27.5 17 40	37.8 22 54	33.6 7 65	33.0 14 66	37.6 21 60	29.4 10 45	F=1.53 p=0.19
Young cattle occupation in number per 10 cows	6.90 1.1 13.5	6.58 3.1 9.4	6.84 3.7 10.6	6.70 3.1 13.5	6.95 1.1 10.7	6.61 3.6 9.4	7.47 5.7 9.7	F=0.43 p=0.83
Milk yield per milking cow (kg) minimum maximum	6298 4850 8266	5942 5408 6872	6313 5694 6923	6331 5860 7906	6623 5449 8266	5671 4850 6545	6376 5677 7069	F=2.56 p=0.032 C vs M;G;P
Total revenue per milking cow (fl.) minimum maximum	5751 4309 7727	5455 4551 6188	5763 4833 6493	5763 4968 7028	5916 4491 7727	5162 4309 5660	5817 5116 6625	F=2.42 p=0.041 M vs T;P;F;C
Average price per calf (not in-calf) (fl.) minimum maximum	513.5 350 666	538.1 415 666	570.8 514 642	504.6 360 651	492.3 385 666	486.4 370 548	521.5 350 641	F=2.58 p=0.031 T vs M;C;P
Average price per milking cow sold (fl.) minimum maximum	1671 1204 2134	1714 1336 2074	1655 1430 1903	1631 1347 1824	1685 1204 2134	1672 1394 2009	1685 1390 2075	F=0.40 p=0.85
Price per 100 kilograms of milk (fl.) minimum maximum	77.86 58.66 81.61	77.39 74.41 81.03	77.34 72.74 80.49	77.73 58.66 81.29	78.34 74.22 81.61	77.29 73.61 80.09	78.03 74.62 80.79	F=0.43 p=0.82

Appendix 1 (part 2): Average 1986/1987 DELAR results per style of farming in terms of parameters for which norms were calculated and available to the researcher. (See for detailed descriptions box 8.1 in chapter 8.)

	TOTAL (n=104)	multiple goalers (G) (n=10)	thrifty farmers (T) (n=13)	practical farmers (P) (n=24)	cowmen (C) (n=34)	machine-men (M) (n=7)	fanatical farmers (F) (n=16)	F, p, and pairs which differ at $\alpha=0.05$
Feed costs per milking cow (fl.)	1048	997	1032	1043	1108	909	1034	F=1.63; p=0.16; M vs C
minimum	564	740	759	734	802	564	940	
maximum	1759	1114	1229	1759	1643	1318	1364	
relative norm-deviation	215	141	223	199	250	214	201	F=0.77; p=0.57
absolute norm-deviation	220	141	230	199	256	228	209	F=1.03; p=0.41
Fodder costs per milking cow (fl.)	520	374	427	585	563	506	504	F=0.82; p=0.54
minimum	-444	-109	-143	188	-444	-51	-70	
maximum	1508	980	843	1182	1508	1024	1080	
relative norm-deviation	75	5	109	90	92	18	59	F=0.25; p=0.94
absolute norm-deviation	228	162	171	206	295	161	234	F=1.76; p=0.13
Concentrate consumption during the grazing period per milking cow (kg)	5.33	5.24	5.14	5.38	5.49	4.47	5.46	F=1.15; p=0.34
minimum	2.7	3.8	4.1	3.2	3.6	2.7	2.7	
maximum	8.9	6.4	6.3	8.0	7.8	6.6	8.9	
relative norm-deviation	1.30	1.22	1.24	1.22	1.37	0.89	1.52	F=0.30; p=0.91
absolute norm-deviation	1.44	1.40	1.27	1.31	1.51	1.43	1.63	F=0.25; p=0.94
Concentrate consumption during the stable period per milking cow (kg)	6.4	5.55	6.49	6.26	6.85	5.43	6.55	F=2.53; p=0.034; M vs C
minimum	3.7	3.7	4.9	3.9	4.4	3.9	5.0	G vs C
maximum	10.9	6.6	9.0	9.5	10.9	7.2	8.9	
relative norm-deviation	-0.17	-1.31	0.08	-0.27	-0.03	0.14	0.07	F=1.37; p=0.24; G vs C;F
absolute norm-deviation	1.25	1.37	1.39	1.41	1.23	0.89	1.06	F=0.57; p=0.72

Appendix 1 (part 2, continued A): Average 1986/1987 DELAR results per style of farming in terms of parameters for which norms were calculated and available to the researcher. (See for detailed descriptions box 8.1 in chapter 8.)

	TOTAL (n=104)	multiple goalers (G) (n=10)	thrifty farmers (T) (n=13)	practical farmers (P) (n=24)	cowmen (C) (n=34)	machine-men (M) (n=7)	fanatical farmers (F) (n=16)	F, p, and pairs which differ at $\alpha=0.05$
Mowing percentage	189	177	185	204	191	166	188	F=0.22; p=0.95
minimum	24	73	115	104	29	75	24	
maximum	714	289	277	594	714	270	314	
relative norm-deviation	21	25	12	33	21	-18	24	F=0.41; p=0.84
absolute norm-deviation	57	32	34	66	64	52	68	F=0.82; p=0.54
Revenue minus feed & fodder costs per milking cow (fl.)	4114	3944	4273	4021	4198	3678	4240	F=1.57; p=0.18
minimum	2825	3391	3530	3434	2825	3121	3278	
maximum	6074	4925	5290	5030	6074	4887	5627	
relative norm-deviation	-316	-144	-361	-300	-390	-284	-271	F=0.70; p=0.63
absolute norm-deviation	416	226	361	368	455	323	412	F=0.67; p=0.65
Revenue minus feed & fodder costs per hectare (fl.)	10973	10250	10546	11532	11042	10679	10947	F=0.66; p=0.65
minimum	7241	7372	8264	7511	7735	7214	8341	
maximum	18484	12892	13045	18484	18276	13380	16008	
relative norm-deviation	-827	-326	-913	-788	-1023	-820	-712	F=0.94; p=0.46
absolute norm-deviation	1021	561	913	925	1217	958	1148	F=1.61; p=0.16; G vs C
Feed & fodder costs per 100 kilograms of milk (fl.)	25.5	23.9	23.5	27.0	25.8	26.1	24.8	F=0.90; p=0.49
minimum	10	17	16	20	10	12	14	
maximum	39	33	32	36	36	39	39	
relative norm-deviation	4.6	2.6	5.2	4.6	5.1	4.3	4.2	F=0.61; p=0.69
absolute norm-deviation	5.4	3.6	5.3	5.0	6.3	4.9	5.6	F=1.39; p=0.23; G vs C

Appendix 1 (part 2, continued B): Average 1986/1987 DELAR results per style of farming in terms of parameters for which norms were calculated and available to the researcher. (See for detailed descriptions box 8.1 in chapter 8.)

	TOTAL (n=104)	multiple goalers (G) (n=10)	thrifty farmers (T) (n=13)	practical farmers (P) (n=24)	cowmen (C) (n=34)	machine-men (M) (n=7)	fanatical farmers (F) (n=16)	F, p, and pairs which differ at $\alpha=0.05$
Price per kilo-VEM of bought-in roughage (fl.)	0.425	0.444	0.426	0.407	0.435	0.428	0.425	F=0.68; p=0.64
minimum	0.18	0.35	0.36	0.18	0.34	0.29	0.31	
maximum	0.60	0.57	0.60	0.54	0.55	0.49	0.55	
relative norm-deviation	0.005	0.024	0.006	-0.013	0.015	0.007	0.008	F=0.68; p=0.64
absolute norm-deviation	0.052	0.062	0.046	0.046	0.048	0.056	0.075	F=1.16; p=0.33
Additional feed & fodder (in kilo-VEM) per hectare of grazing land	13290	12888	12391	15442	12449	12609	13126	F=0.54; p=0.75
minimum	5209	6495	5977	7444	5283	6673	5209	
maximum	50979	42495	25400	50979	27710	22524	31195	
relative norm-deviation	1202	-373	1456	1667	1212	782	1473	F=1.39; p=0.23; G vs P
absolute norm-deviation	1931	1469	1585	1941	2137	1721	2141	F=0.47; p=0.80
Feed & fodder costs per milking cow (fl.)	1617	1386	1490	1705	1717	1484	1577	F=1.85; p=0.11; G vs C
minimum	585	926	967	1233	585	773	905	
maximum	2850	1894	1952	2255	2850	2322	2444	
relative norm-deviation	292	146	332	290	342	232	273	F=0.89; p=0.49
absolute norm-deviation	346	214	337	314	421	260	358	F=2.16; p=0.065; G vs C
Turnover and accretion per milking cow (fl.)	793	855	877	789	727	773	840	F=0.93; p=0.46
minimum	-52	527	602	443	-52	544	563	
maximum	1595	1202	1172	1460	1493	1343	1595	
relative norm-deviation	-6	31	-29	60	-48	-51	2	F=0.70; p=0.63
absolute norm-deviation	146	62	115	182	154	140	155	F=0.67; p=0.65

Appendix 2

Report written on the occasion of my first encounter with an excursion-group meeting on friday October 6, 1989.

(This report is included in order to provide the reader with an impression of how excursion-groups operate. Although not exemplary for my field-notes, I have chosen to include my own *first* impression because presumably it expresses best the things and issues that surprise and/or strike a layman when first attending an excursion-group meeting.)

The meeting takes place at the enterprise of Helmert Klaassen in Helenaveen. The meeting starts at 4 o'clock p.m. I arrive early, and meet with Klaassen in the canteen. Klaassen explains that normally the meetings take place later in the afternoon because the daylight lasts longer. The days are becoming shorter now, and the crop is nearly at its end. In a few weeks time the glasshouse will be cleared, and new plants will arrive.

Klaassen seems a quiet, gentle and thoughtful person. Later on it will become clear that he does not participate in the existing postal ERCS, but I notice that there are various graphs nailed on the wall, amongst others the number of cucumbers yielded per square meter per week in 1988 and 1989. While waiting for the others, we talk about trucks and driving licences; I have noticed on arrival that Klaassen has his own truck for bringing cucumbers to the auction. At 4.05 the first growers arrive, and at 4.15 we are complete. Eleven persons altogether. Klaassen appears to be the excursion-group leader of this group; that the meeting takes place at his own enterprise is a coincidence.

Klaassen reads aloud at a very high speed his registration material of the last three weeks. All growers fill up the data on a special form. Sometimes somebody asks a short question, and cries of disbelief are occasionally heard. Klaassen continues to explain the rights of the case. Some of the settings he relates to the meagre prices of the moment. In his view, growth need not be optimal under the present circumstances. If prices had been higher he would have had a higher temperature and humidity.

On the basis of a few figures, some small discussions emerge, for example on the advantages of dusting instead of spraying, and on how you can make sure that there is a good circulation of air while doing so. Some even say that they open the windows a little in order to achieve this. The growers also talk about the consequences of spraying and dusting for mildew infection. It is argued that, because Klaassen has had his windows closed for prolonged periods on account of the spraying activities, he now has more problems with mildew. I can't follow it all. Much of what the growers say is abracadabra to me.

Following this, the growers thoroughly discuss issues related to the market such as the supply of cucumbers, prices, the Spanish cucumbers, etc. Furthermore, a 'new' and more concentrated chemical remedy is evaluated; both experiences and points of sale are exchanged. I notice that several discussions have very little to do with the figures that are exchanged.

It occurs to me that the connections between various things are terribly complex. There is an enormous number of variables that can be manipulated, and each day important estimations must be made. Also, it strikes me that the discussions take place in a very orderly fashion.

After half an hour we enter the glasshouse. The first time for me. In no time individual growers and small groups disappear between the rows of cucumber plants. In the gangway some growers follow up on the discussions held earlier. The glasshouse impresses me. White plastic, green plants and heating tubes (which simultaneously function as rails for trolleys) everywhere. All plants are individually fed. There is a remarkable difference in 'temperature' or 'climate' between the old and the new section of the glasshouse. The two are connected, and a grower explains that, according to the climate computer, the climate in the two sections is supposedly the same. But even I feel the difference, and the grower argues that the new glasshouses always feel cooler. Strange.

We walk around for three quarters of an hour and I learn a lot about cucumbers. What the others learn and think I can only guess at. I assume that most of them make comparisons with their own enterprise.

Walking back to the canteen, I am surprised to see a machine for picking up sheets of (packing) paper which incorporates an ordinary vacuum cleaner. Klaassen explains that many growers have built things like this. While we were in the glasshouse a few Turkish people from Germany have arrived, who are busy loading crooked cucumbers into a van. They know their way around; the coffee machine, the toilet, etc. They must be regular visitors. Klaassen emphasizes that not all growers are so easy with letting foreign traders enter their enterprise; most of the lock them doors tightly. He further explains that the Turks like the crooked cucumbers, and that selling them outside the auction is more profitable for him. The other growers do not seem to object to this, even if I assume that what I see happening is probably illegal.

In the hall (which seems huge to me, but which, according to Klaassen, is nowadays a small one) I also see an old emergency generator. A grower explains that the whole glasshouse is operated with electricity, so that if there is a black out it is a disaster. Most growers, therefore, have an generator.

We meet again in the canteen. It appears that they want to give me the opportunity to ask a few questions. I am surprised; they seem really interested to participate in the study. I had only expected to gain a first impression, and explicitly asked them to go about their business as usual. I did not plan to ask questions and have not prepared any, but I cannot let them down now, can I?

I ask them how representative this meeting was. It appears that they do not usually meet after the walk through the glasshouse. They used to do that earlier on, but it has become diluted. Also, they normally meet longer in the beginning, but they figured that I would be more interested in walking through the glasshouse. Furthermore, in spring they have much more prolonged discussions on the settings of the computer; when the crop is young the climate is even more important than it is now. Furthermore, the modes of working differ per excursion-group; there are other excursion-groups that first go into the glasshouse, and meet in the canteen only afterwards. In Asten there is a group of six growers which visits three enterprises a week, and thus they visit each enterprise on a fortnightly basis. It is stressed that one can only do that if the enterprises are situated very close together. The advantage is that with such an intensive schedule one manages to get a better view on the development of a crop. In this group, each enterprise is visited about four times a year, which means about two times per planting.

I continue to ask why they have not used the registration material of the existing postal ERCS in this meeting. The growers agree that the registration material arrives too late to be of use. Nobody is able to make clear what they use the existing ERCS for. One grower remarks that it is useful to read aloud the registration material on the spot, rather than to copy the material in advance; by having to write the material down it tends to sink in better.

Another grower remarks that figures on paper are of little use; one has to see the crop. However, the registration is useful in making clear that there are differences between growers; previously everybody said that such differences existed, but it was never supported with concrete evidence. I ask where these differences stem from. It is suggested that this is in many cases a mystery; some growers with old glasshouses produce more than growers with a technically superior new glasshouse. Differences in craftsmanship and 'feeling' are raised as important explanations. I give an example of strategic diversity in dairy farming, but my example does not meet with a favourable response. It is argued that hardly any strategic diversity exists in horticulture. The numbers of cucumbers yielded per square meter per week is what counts; it is suggested that having more cucumbers is always better (but from the discussions at the beginning of the meeting I conclude that Klaassen at least seems to disagree with this). Someone suggests that, to a certain extent, the production of quantity is incompatible with the production of quality, and that -in relation to this- there is considerable debate concerning the pros and cons of having two or three plantings per year.

When asked about how honest they can be towards each other, it is stressed by several growers that they can be very straightforward with each other. If someone finds that the crop looks bad, he will say so. It is put forward that growers can only learn from each other if they are really honest.

Appendix 3

The extent to which the existing ERCS meets (and/or can be modified to meet) the design-criteria formulated in section 9.4 (see box 9.6).

Criterion 1: The postal ERCS provides an abundance of parameters (see section 9.2). Although Technical Fine-Tuners especially are still in need of much more detailed information, these cannot be realistically provided on a weekly print-out. In principle, the parameters that are included seem quite adequate for stimulating further discussions among growers with different interests and strategies. Furthermore, the postal ERCS anticipates diversity in that it allows growers to participate at various levels (see section 9.2).

Criterion 2: Although there seems to be very little connection between the postal ERCS and the excursion-groups (see section 9.4), there are opportunities to partly resolve this. First, anonymity could be officially lifted; if growers get -at the beginning of each season- a list which declares which growers correspond to which enterprise numbers on the print-out, very few growers would object. An explicit mentioning of the names on each print-out, however, would probably lead to more protest. Second, members of the different excursion-groups could be grouped together on the print-out so that an overview of group results can be easily obtained. Third, the groups could be composed in such a way that they include solely ERCS participants or non-ERCS participants (this would probably lead to an increase in the number of ERCS participants as well). Thereby, the level of ERCS participation and/or a previously indicated area of interest could possibly serve as one of the additional criteria for group composition.

The main bottleneck for connecting the postal ERCS with the excursion-groups is that the postal ERCS will never be able to deliver up-to-date parameters for each enterprise at the excursion-group meetings themselves; the parameters on the print-out will always remain at least one week old. However, I have argued earlier on that this does not do much harm to the functioning of the excursion-groups, since growers have developed alternative means of exchanging up-to-date information on the spot (see section 9.4). In theory, the provision of figures in advance of excursion-group meetings gives growers the opportunity to prepare themselves more thoroughly. Some growers, however, argue that it would be detrimental to have the figures in advance, since -in practice- growers do *not* prepare, and need the figures to be read aloud in order to identify discrepancies and interesting points for discussion.

Despite the fact that it is difficult to increase the speed of exchange in the postal ERCS, my earlier suggestions for improving the connection between the ERCS and the excursion-groups remain valid since cucumber growers frequently refer to the past during excursion-group meetings. After all, growing cucumbers is an intricate process in which past interventions, production circumstances and results are important elements for explaining the state of affairs in a particular week.

Criterion 3: The participants in the postal ERCS already receive -at the beginning of each season- a list with important context information, which is especially suited for making strategic comparisons (see box 9.4).

Criterion 4: No provisions are made in the postal ERCS to allow specific individuals or excursion-groups to exchange parameters that only *they* are interested in. Provided that a connection is made between the excursion-groups and the ERCS (criterion 2) such opportunities could be easily provided by including a few 'free columns' on the print-out; that is, columns that excursion-groups can fill up with parameters of their own choosing.

Criterion 5: The flexibility of the postal ERCS is very high since the Study Club Board and the Registration Committee of the Stoke-Cucumber Study Club Brabant/Limburg can decide for themselves how to change their own ERCS (e.g. on which new parameters to include). If necessary, changes can be implemented quickly since communication lines are short, and relatively few people are involved. Moreover, the (software-)technical complexity of the ERCS is limited, so that adaptations can be easily implemented.

Criterion 6: Although the Registration Committee has issued certain guidelines on measurement and calculation procedures, it remains difficult to ensure that these are adhered to. In relation to climate registration, validity and reliability problems are also counteracted by grouping growers on the print-out according to the type of climate computer they have. Similarly, in relation to production figures the auctions are called upon to provide reliable registration material. However, notwithstanding these regulations and procedures, there are still a multitude of contextual factors which may hamper the validity and thereby the comparability of parameters (see sections 9.2 and 9.4). This is likely to remain a problem which can only be alleviated during discussion in the excursion-groups; thus, also from this perspective a connection between the ERCS and the excursion-groups (criterion 2) seems crucial.

Criterion 7: In relation to the postal ERCS it would be quite easy to announce procedures for correcting faulty parameters. Mistakes could be collected at a central point, and be regularly reported at the weekly print-out so that growers could correct earlier print-outs. In the central database corrections should be made as well, so that cumulative figures on future print-outs are not affected.

Criterion 8: On the basis of this study, the Study Club Board is -in principle- in the position to realistically present the postal ERCS as a tool which facilitates gradual learning, rather than as a tool for drawing general conclusions.

Criterion 9: In the postal ERCS the opportunities for easy retrieval of, and 'playing around' with figures will remain limited, which is a drawback for enhancing learning. Although the Registration Committee provides participants with a selection of graphical representations of their results at the end of each season, it would clearly be an advantage if growers would have more freedom to regularly manipulate, select and represent figures in the ERCS database according to their own insight. In principle, it would be possible to regularly distribute floppy discs with database material, which growers could then play around with using their own spreadsheet program.

Criteria 10 and 12: In principle, it is quite easy to sanction participants who regularly fail to send in their registration material in time. One could imagine, for example, that those who violate discipline would no longer receive print-outs. Similarly, official sanctions could be issued for those who 'leak' registration material to unauthorized persons outside the study club. Given the fact that violation would be hard to prove, such sanctions could be announced merely for their symbolic meaning, which is that growers should be careful with other growers' registration material.

Criteria 11 and 14: In the context of its relationships with the NTS and extension services, the Cucumber Study Club Brabant/Limburg has already access to training facilities for discussion leaders. In principle, the Study Club Board could try to influence the curriculum of such courses in such a way that attention is paid to achieving a balanced integration of, on the one hand, ERCS-related activities and discussion, and, on the other, regular excursion-group functions. Similarly, the Board could stimulate the training of ERCS participants in drawing adequate conclusions on the basis of ERCS material. This could either be integrated in the curriculum of existing management courses, or -for example in cooperation with NTS and extension services- be offered in special courses and/or during the so-called winter meetings.

Criterion 13: In order to fight competitive excesses the Study Club Board could actively counteract the idea that the ERCS is mainly an arena for identifying the 'winners' and the 'losers'. Of course, it will never be possible to completely eliminate the competitive games for which some growers thankfully use the postal ERCS. But by stressing the learning opportunities it entails, the image of the ERCS might be slightly altered. It would probably not be wise to take out the competitive sting by eliminating some production figures (and especially the cumulative turnover in guilders per glasshouse square meter) for -whether one likes it or not- they are a crucial point of reference for evaluating technical practices. However, it could be attempted to reduce excessive fixation on such parameters. In particular, one could think of the provision of calculation examples which show that enterprises with a relatively low cumulative turnover in guilders per glasshouse square meter, can -if all other costs are accounted for- still end up with a similar net income.

Criterion 15: Given the widespread participation in excursion-groups, we must conclude that -in the end- most growers are reasonably satisfied with the composition of their excursion-group. Given the highly sensitive nature of decisions concerning group composition, it seems that -even if I am not aware of all the complex negotiations which take place- there is sufficient opportunity for growers to influence these.

Appendix 4

The extent to which INFOTUIN/TVPC and TELETUIN meet those design-criteria formulated in section 9.4. that were not deemed as being of vital importance (see box 9.6).

Criterion 3: provision of additional context information
In both INFOTUIN/TVPC and TELETUIN arrangements for exchanging relevant context information for making 'strategic' comparisons are roughly similar to those which are included in the postal ERCS. A list with relevant characteristics in this respect is provided for at the beginning of each season. Thereby the list included in INFOTUIN/TVPC is most extensive. Since the arrangements for providing relevant context information in all three cases seem to depend predominantly on agreements within the regional study club, there is little reason to say that one ERCS has inherent advantages over others in this respect.

Criteria 6 and 7: opportunities for (a) assessing validity and reliability, and (b) making corrections
In both TELETUIN, INFOTUIN/TVPC and the postal ERCS the making of guidelines for measuring and/or calculating parameters seems to be a regional study club affair. In all three cases we see that: (a) it is difficult to enforce these regulations; (b) that their scope for ensuring validity is limited; and (c) that a connection between the ERCS and the functioning of the excursion-groups seems crucial for resolving reliability and validity problems (see appendix 3). There seems little ground for arguing that either the postal ERCS or the 'automated' versions have certain advantages in this respect. For the making of corrections, however, the 'automated' ERCS (and in particular INFOTUIN/TVPC) has certain advantages. First, corrections -if entered in the central database- can be automatically communicated and added to growers' local databases; thus, growers do not have to manually correct print-outs. Second, INFOTUIN/TVPC has a facility for preventing the making of mistakes. When the parameter values are entered, the INFOTUIN/TVPC software checks immediately if this value falls within a realistic range; if this is not the case the grower will have to correct the entered value before he or she can continue to fill up the electronic form.

Criterion 8: realistic presentation
All three ERCS were -in the recent past- promoted with the use of questionable arguments. Both the promotional activities around INFOTUIN and TELETUIN stressed the importance of fast exchange and standardized registration, whereas I have shown in section 9.4 that the blessings of these properties can be considerably shaded. At a later stage, the importance of having facilities for processing and analyzing registration material became an additional argument. Although this argument seems to make much more sense than the former two, I have shown in section 9.6 that the processing facilities have problematic aspects as well. The prime expectation that was raised in relation to the postal ERCS was that it would help

growers to draw general conclusions in relation to 'the best way to grow cucumbers'. I have argued in section 9.4 that this too is a misleading argument.

In principle, both INFOTUIN/TVPC, TELETUIN and the postal ERCS can -in order to avoid disappointment- be presented more realistically; that is, as a tool (next to others) that supports and enhances gradual learning on growing cucumbers. Since the existing postal ERCS is not connected with commercial interests, however, it may be somewhat less susceptible for unrealistic presentation.

Criterion 10: including sanctions on violation of discipline

In principle, sanctions on violating discipline can be included in any ERCS, including the postal one (see appendix 3). In automated ERCS, however, such sanctions can be implemented automatically. In INFOTUIN/TVPC, it has been made effectively impossible to supply incomplete electronic forms. Moreover, the parameters which are provided must fall within a realistic range (of course growers can still supply fictitious parameter values). In theory, such measures are taken in TELETUIN as well, but they do not seem to be water-tight. Moreover, parameters are not checked, so a grower can in principle supply only zeros and still receive other growers' registration material (see section 10.4). Some growers are rather unhappy with this situation.

> "Of the 30 participants there were about seven or eight who were not really convinced; they participate mainly to get access to others, and not fall behind. Some of these do not correctly or completely fill up the form, and that is a terrible pity. Really they should introduce the death-penalty for that, so to speak."

In addition to the automatic enforcement of completeness, automated ERCS can also automatically deny access to the registration material to those that have not (yet) entered their own parameter values. Such automatic sanctions can be seen as an advantage, since they reduce work and -by making the sanctions more anonymous and consistent- lessen the likelihood that frictions occur between members of the study club.

Criteria 11 and 14: provision of training for participants and discussion leaders

At present the SITU, the auctions and (more in particular) the NTS (i.e. those who are involved in the development and exploitation of INFOTUIN/TVPC) have a greater capacity for (and experience in) the organization of adequate courses for discussion leaders and/or ERCS participants. However, although the capacity of DACOM and regional study clubs seems limited in this respect, it must be noted that both the southern and the northern cucumber study clubs are part of the NTS. Thus, both users of TELETUIN or the postal ERCS may claim access to NTS courses in this field, and organize pressure that these are designed in such a way that they are of use to non-INFOTUIN/TVPC users as well. Furthermore, the regional study clubs can cooperate with others (e.g. extension workers) in order to make sure that relevant courses materialize (see also my discussion in appendix 3). In the case of TELETUIN, a close cooperation has thus emerged between DACOM, the northern study club and the local extension worker, whereby the latter is amongst others extensively involved in supporting growers in their use of TELETUIN.

Apart from the organization of training course and/or meetings, the availability of adequate user manuals is a relevant aspect in relation to especially criterion 14 as well. Extensive user manuals (of differential quality) are available for both INFOTUIN and TVPC.

TELETUIN provides a 'manual' of about two pages. Thus, in this respect INFOTUIN/TVPC seems to be more 'professional' as well. However, it must be noted that in the interviews virtually no criticisms were expressed in relation to the 'user friendliness' of either INFOTUIN/TVPC or TELETUIN. In fact, several TELETUIN users indicated that they did not feel handicapped by the lack of a user manual since TELETUIN's pull-down menus made its use very easy. Nevertheless, it was striking that -in relation to TELETUIN especially- growers were frequently unable to answer immediately questions relating to some of the opportunities offered (e.g. relating to which graphs could be made and which not). However, after some quick browsing within TELETUIN they were always able to provide an answer. Thus, the messy set-up of especially the graphical module seems to limit growers' immediate overview of the package.

In all, it can be concluded that INFOTUIN/TVPC has a slight advantage over TELETUIN (and to a lesser extent the postal ERCS) in relation to criterion 14 especially.

Criterion 12: preventing the spreading of registration material outside the study club

In my earlier discussion on criterion 12 in appendix 3, it was already indicated that it is difficult to exclude the possibility of leakage of registration material to unauthorized persons; this holds not only for the postal ERCS but also -and due to hacking opportunities probably even more- for the 'automated' ERCS. To a large extent, preventing unauthorized spreading depends on social control and mutual trust among those involved, including those who control the central database (in all three cases such control involves third persons in addition to growers and growers' organizations). I have no indications relating to the quality of protection measures against hacking that are implemented in INFOTUIN/TVPC and TELETUIN.

Since individual growers -who have copies of (parts of) the central database- are probably the weakest point in the chain of protection measures, it can be assumed that the three ERCS are roughly equivalent in this respect.

Criterion 13: combatting competitive excesses

The occurrence of competitive excesses seems highly dependent on the 'atmosphere' within particular groups of growers. Since all three ERCS include the necessary 'ingredients' for competition, it can be argued that -regardless of the ERCS that is used- the emergence of competitive excesses is associated mainly with the local study club history and circumstances. Thus, solutions in this respect depend highly on local/regional interventions as well, rather than on the specific ERCS that is adopted.

Additional considerations: costs and continuity

Clearly, the required investments in both money and time are much lower in case of the postal ERCS than for the two 'automated' ERCS. In 1989, participants of the postal ERCS had to pay fl. 350.- subscription fee. In case of TELETUIN, growers had to make a once only investment of fl. 650.- in the software, while the yearly subscription fee was fl. 750.-. For INFOTUIN, growers had to pay a subscription fee of fl. 390.-, whereby it must be noted that a considerable amount of telephone costs were involved; in total the yearly costs of using INFOTUIN were estimated by NTS personnel at fl. 700.-. Apart from that, growers had to make a unique investment in both TVPC (fl. 500.-) and videotex communication software (± fl. 100.-). On top of all this, users of 'automated' ERCS have to invest in a PC (with hard disc), a printer and a modem; depending on the supplier and the type of equipment chosen these hardware costs varied from about fl. 5,000.- to about fl. 12,000.-. Even if most growers already had computer equipment before starting to use INFOTUIN/TVPC or TELETUIN, such investments in hardware were hard to avoid since suppliers of climate computers and registration packages did not wish to take responsibility for problems with climate computers that would be caused by interference of alien software. Apart from financial investments, the use of both INFOTUIN/TVPC and TELETUIN requires considerable time investments for becoming familiar with both software and hardware.

While at present continuity in the case of TELETUIN and the postal ERCS is highly dependent on individuals (see also appendix 3), INFOTUIN/TVPC has a much broader institutional basis. At national level, the NTS has a coordinator who monitors INFOTUIN/TVPC affairs, and at the regional level INFOTUIN/TVPC is supported by study club supervisors, regional controllers and auction personnel. Furthermore, access to government subsidies can -in the medium to long term- be secured through SITU. Thus, to a certain extent effective maintenance, distribution, training and support can be guaranteed in the long term. In the case of TELETUIN, the long-term continuity seems more vulnerable; not only because of the cruciality of particular persons but also because of the fact that auctions are reluctant to cooperate (e.g. they refuse to provide TELETUIN with production figures electronically, see chapter 10 for further details). From the point of view of continuity, therefore, INFOTUIN/TVPC may have advantages over both TELETUIN and the postal ERCS.

List of abbreviations and acronyms

ADP	Automated Data Processing
AKIS	Agricultural Knowledge and Information System(s)
ASIU	Advisory System(s) for Independent Use
ASSU	Advisory System(s) for Supervised Use
BAP	Fertilization Advisory Program / Bemestings Advies Programma
CAB	Committee Automation Enterprise Comparison / Commissie Automatisering Bedrijfsvergelijking
CBS	Netherlands Central Bureau of Statistics / Centraal Bureau voor de Statistiek
CBT	Central Bureau of Horticultural Auctions / Centraal Bureau Tuinbouwveilingen
CL	Cees Leeuwis
CLO	Central Agricultural Organizations / Centrale Landbouworganisaties
CM	Cowmen
CMC	Computer Mediated Communications
COAL	Coordinating Body for Automation Development in behalf of Agricultural and Horticultural Enterprises / Coördinatie Orgaan voor de Automatiseringsontwikkeling ten behoeve van Land- en Tuinbouwbedrijven
CRA	Extension Service Cattle Farming Arnhem / Consulentschap Rundveehouderij Arnhem
CT	Communication Technolog(y)(ies)
DACOM	company name: stems from Data Communication
DELAR	Partial Administration for Cattle Farming / Deeladministratie voor de Rundveehouderij
DICOTU	Society of Digital Process-Computer-Systems for Horticulture / Vereniging van Digitale Procescomputersystemen voor de Tuinbouw
DLO	Service for Agricultural Research / Dienst Landbouwkundig Onderzoek
DLV	Service for Agricultural Extension / Dienst Landbouw Voorlichting
DSS	Decision Support System(s)
DTH	Database for Horticulture and Trade / Databank Tuinbouw en Handel
ELM	Elaboration Likelihood Model
EPIPRE	Epidemic, Prediction and Prevention / Epidemie, Predictie en Preventie
ERCS	Enterprise Registration and Comparison System(s)
ES	Expert System(s)
ESS	Extension Supporting System(s)
ETHICS	Effective Technical and Human Implementation of Computer Systems

EWRS	Extension Worker Replacing System(s)
EWSDS	Extension Worker Support*ed* System(s)
EWSGS	Extension Worker Support*ing* System(s)
FF	Fanatical Farmer(s)
FS	Feedback System(s)
GROEINET	program name: stems from Growth Network
GSD	Society for Animal Health Care / Stichting Gezondheidsdienst voor Dieren
HAS	Human Activity System(s)
IBV	Information Policy Plan Extension / Informatie-Beleidsplan Voorlichting
ICM	Integrated Chain Management
IE	Information Engineering
IEM	Information Engineering Methodology
IKC-V	Information and Knowledge Centre for Animal Farming / Informatie en Kennis Centrum Veehouderij
INFOTUIN	program name: stems from Information Garden
INSP-LV	Informatics Stimulation Plan - Ministry of Agriculture and Fisheries / Informatica Stimuleringsplan - Ministerie van Landbouw en Visserij
INSP-LO	Informatics Stimulation Plan Agricultural Research / Informatica Stimuleringsplan - Landbouwkundig Onderzoek
INTERMATION	company name: stems from International Automation
IT	Information Technolog(y)(ies)
KIS	Knowledge and Information System(s)
KMV	Coupling Milk Inspection Cattle Feeding / Koppeling Melkcontrole Veevoeding
LCB	National Committee for Enterprise Comparison / Landelijke Commissie Bedrijfsvergelijking
LCI	National Committee Information Provision / Landelijke Commissie Informatievoorziening
LEI	Agricultural Economics Institute / Landbouw-Economisch Instituut
LRB	National Council for Enterprise Development in Agriculture / Landelijke Raad voor de Bedrijfsontwikkeling in de Landbouw
MELVO	Supervision System Milk/Feed & Fodder / Begeleidingssysteem Melk/Voer
MEMOCOM	name of electronic mail network: stems from Memo Communication
MG	Multiple Goaler(s)
MIS	Management Information System(s)
MINTS	Management Intelligence System(s)
MLV	Ministry of Agriculture and Fisheries / Ministerie van Landbouw en Visserij
MLNV	Ministry of Agriculture, Fisheries and Nature Conservation / Ministerie van Landbouw, Visserij en Natuurbeheer
MM	Machinemen
MRIJ	Meuse Rhine IJssel / Maas Rijn IJssel
MSS	Management Supporting System(s)

MSX	Microsoft Extended BASIC (Beginners All-Purpose Symbolic Instruction Code)
NCB	North-Brabant Christian Farmers' Alliance / Noordbrabantse Christelijke Boerenbond
NRLO	National Council for Agricultural Research / Nationale Raad voor Landbouwkundig Onderzoek
NRS	Netherlands Cattle Syndicate / Nederlands Rundvee Syndicaat
NS	Networking System(s)
NTS	Network Transaction System(s)
NTS	Society for Dutch Horticulture Study Groups / Vereniging van Nederlandse Tuinbouwstudiegroepen
O&S Fund	Foundation Development and Sanitation Fund / Stichting Ontwikkelings- en Saneringsfonds voor de Landbouw
PBG	Project Group Enterprise Comparison for Glasshouse Vegetables / Projectgroup Bedrijfsvergelijking Glasgroente
PF	Practical Farmer(s)
PI	Policy Instrument
PR	Experimental Station for Cattle Farming / Proefstation Rundveehouderij
PTB	Experimental Station for Flower Growing in the Netherlands / Proefstation voor de Bloemisterij in Nederland
PTOG	Experimental Station for Glasshouse Horticulture / Proefstation voor Tuinbouw Onder Glas
PTT	company name: stems from Post Telephone Telegraph
RAAKS	Rapid Appraisal of Agricultural Knowledge Systems
RCB	Regional Committee Enterprise Comparison / Regionale Commissie Bedrijfsvergelijking
SAP	Steer Advisory Program / Stier Advies Programma
SAS	Search and Access System(s)
SDM	System Development Methodology
SEB	Cooperation Coalition External Enterprise Comparison / Samenwerkingsverband Externe Bedrijfsvergelijking
SEIN	Foundation Exploitation Information Processing for the NTS / Stichting Exploitatie Informatieverwerking voor de NTS
SIM	Standard Information Model(s)
SIPLU	Foundation Information Processing for the Poultry Branch / Stichting Informatieverwerking Pluimveehouderij
SITU	Foundation Information Processing for Horticulture / Stichting Informatieverwerking Tuinbouw
SIVA	Foundation Information Processing for the Pig Branch / Stichting Informatieverwerking Varkenshouderij
SIVAK	Foundation Information-Care for Arable Farming / Stichting Informatie-Verzorging Pluimveehouderij
SNL	Structure-bill Agriculture /Structuurnota Landbouw
SNOT	Foundation New Developments Horticulture / Stichting Nieuwe Ontwikkelingen Tuinbouw

SSM	Soft Systems Methodology
STAA	Socio-Technical Approach to Automation-problems
TAURUS	Branch Organization Automation and Uniformation for the Cattle Branch / Takorganisatie Automatisering en Uniformering Rundveehouderij Sector
TEA	Technical/Economic Administration(s) / Technisch/Economische Administratie(s)
TECHNOLUTION	company name: stems from Technological Solution
TELETUIN	program name: stems from Telecommunication Garden
TF	Thrifty Farmer(s)
TVPC	Crop Comparison on Personal Computer / Teelt Vergelijking op de Personal Computer
TWG	Technical Working Group of the LCB / Technische Werkgroep van de LCB
VEM	Feed & Fodder Unit Milk / Voeder Eenheid Melk
VOS-WELKE	project group Extension Supporting Systems - Inventory / projectgroep Voorlichtings Ondersteunende Systemen - Welke
WAB	Working Group Automation Enterprise Comparison / Werkgroep Automatisering Bedrijfsvergelijking

References

Aarnink, B.H.M. (1987), Mijn man werkt en ik help mee. M.Sc. thesis. Department of Sociology of Rural Development, WAU. Wageningen.

Aarnink, B.H.M. & Kingma, K. (1991), *The shamba is like a child: Women in agriculture in Tanzania, part I.* Women and Autonomy Centre (VENA). Leiden.

Aarts, M.N.C. & C.M.J. Van Woerkum (1992), *Communicatie als beleidsinstrument: Een literatuurstudie ten behoeve van een onderzoeksprogramma.* Department of Extension Science, WAU. Wageningen.

Aarts, M.N.C. & C.M.J. Van Woerkum (forthcoming), De integratie van communicatie en overheidsbeleid. (Submitted to: Beleid en Maatschappij).

Ajzen, I. & M. Fishbein (1980), *Understanding attitudes and predicting social behaviour.* Prentice-Hall. Englewood Cliffs.

Alba, R.D. (1982), Taking stock of network analysis: A decade's results. In: Bacharach, S.B. (ed.) (1982), *Research in the sociology of organizations.* pp. 39-74. JAI Press. Greenwich.

Alkemade, A. (1990), Samenvatting inventarisatie informatica-ontwikkelingen in de Glastuinbouw (concept). Agritect Advies. Gouda.

Alkemade, A. (1991), De informatica-ontwikkelingen in de glastuinbouw: Resultaten en verwachte ontwikkelingen. Agritect Advies. Gouda.

Alleblas, J.T.W. (1987), *Management in de glastuinbouw: Een zaak van passen en meten.* LEI research report no. 34. LEI. The Hague.

Alter, S.L. (1980), *Decision Support Systems: Current practice and continuing challenge.* Addison-Wesley. Reading.

Althusser, L. (1969), *For Marx.* Penguin Books Ltd. Hardmondsworth.

Ackoff, R.L. (1967), Management Misinformation Systems. In: *Management Science*, Vol. 14, No. 4, pp. B147-B156.

Ackoff, R.L. (1974), *Redesigning the future.* J. Wiley & Sons. New York.

Ackoff, R.L. (1979), Resurrecting the future of Operational Research. In: *Journal of the Operational Research Society*, Vol. 30, No. 3, pp. 189-199.

Ackoff, R.L. (1981), *Creating the corporate future.* J. Wiley & Sons. New York.

Amin S. (1974), *Accumulation on a worldscale: A critique of the theory of underdevelopment.* Monthly Review Press. New York/London

Amin, S. (1976), Akkumulatie en ontwikkeling in de hedendaagse wereld - Een theoretisch model. De overgangsproblematiek. In: Sunschrift 104: *Imperialisme en onderontwikkeling.* pp. 57-79. Socialistische Uitgeverij Nijmegen. Nijmegen.

Amsterdamska, O. (1990), Surely you are joking, Monsieur Latour! In: *Science, Technology & Human Values*, Vol 15, No. 4, p.495-504.

Annevelink, E & W. Huisman (1991), Agro Informatics in the Netherlands. In: *Agro Informatica*, Jaargang 4, Nr. 3, pp. 17-21.

Arce, A. (1989), The social construction of agrarian development: A case study of producer-bureaucrat relations in an irrigation unit in Western Mexico. In: Long, N. (ed.) (1989b), pp. 11-52.

Arce, A. & N. Long (1987), The dynamics of knowledge interfaces between Mexican agricultural bureaucrats and peasants: A case-study from Jalisco. In: *Boletín de Estudios Latinoamericanos y del Caribe*, Vol. 43, pp. 5-30.

Arnold, E. and Guy, K. (1986), *Parallel convergence; National strategies in information technology.* Frances Pinter. London.

Ascroft, J.R., N.G. Röling, F. Chege & J. Kariuki (1973), *Extension and the forgotten farmer.* Afdelingen der Sociale Wetenschappen van de Landbouwhogeschool, No. 37. WAU. Wageningen.

Ashby, W.R. (1956), *An introduction to cybernetics.* Chapman & Hall. London.

Ausher, R. (1991), Computer supported generation and diffusion of agricultural technologies in developing countries. In: D. Kuiper & N.G. Röling (eds.) (1991), pp. 175-184.

Austin, J.L. (1971), *How to do things with words.* The William James lectures delivered at Harvard University in 1955. Oxford University Press. Oxford.

Austin, J.L. (1970), *Philosophical papers* (2nd edition, edited by J.O. Urmson & G.J. Warnock). Oxford University Press. Oxford.

Bandura, A. (1986), *Social foundations of thought and action: A social cognitive theory.* Prentice-Hall, Englewood Cliffs.

Barrow, J.D. (1990), Why is the universe mathematical? In: *Nuova Civiltá delle Macchine*, Anno VIII, No. 4(32).

Bartels-Mertens, A.C.M., A.J.M. Beulens, C.A. van Loon & D. Schuyl-Laros (1992), Object-georiënteerde systeemontwikkeling: Een trend in de toekomst? In: *Agro Informatica*, Jaargang 5, Nr. 2, pp. 9-17.

Barth, F. (1967), Economic spheres in Darfur. In: R. Firth (ed.) (1967), *Themes in Economic Anthropology.* pp. 149-174. Tavistock Publications. London.

Bawden, R. & R. Macadam (1991), Action researching systems - extension reconstructed. In: H.J. Tillmann et al. (1991), pp. 368-386.

Beal, G.M., W. Dissanayake, & S. Konoshima (eds.) (1986), *Knowledge generation, exchange and utilization.* Westview Press. Boulder.

Beer, S. (1985), *Diagnosing the system for organizations.* J. Wiley & Sons. Chichester.

Beers, G. (1991a), *Problemen, planning en kennis; Een onderzoek naar de processen achter succes en falen van een automatiseringsproject.* Uitgeverij Eburon. Delft.

Beers, G. (1991b), Op zoek naar theoretische grondslagen voor informatie-modellen - het GRIM onderzoek. In: *Agro-informaticareeks*, Nr. 5, pp. 127-133. VIAS. Wageningen.

Beers, G. (1991c), Projecten falen door gebrekkig leerproces: Promotie-onderzoek 'succes- en faalfactoren bij automatiseringsprojecten'. In: *Computable*, Jaargang 24, Week 12, pp. 33-35.

Bemelmans, T.M.A. (1987), *Bestuurlijke informatiesystemen en automatisering.* H.E. Stenfert Kroese B.V. Leiden/Antwerpen.

Beniger, J.R. (1986), *The control revolution: Technological and economic origins of the information society.* Harvard University Press. Cambridge.

Beniger, J.R. (1991), Conceptualizing information technology as organization, and vice versa. In: J. Fulk & C.W. Steinfield (eds.) (1990), pp. 29-45.

Benvenuti, B. (1982), De technologisch administratieve taakomgeving (TATE) van landbouwbedrijven. In: *Marquetalia*, Nr. 5, pp. 111-136.

Benvenuti, B. (1991a), *Geschriften over landbouw, structuur en technologie.* Wageningen Studies in Sociology Nr. 29. WAU. Wageningen.

Benvenuti, B. (1991b), Towards the formalization of professional knowledge in farming: Growing problems for agricultural extension. In: H.J. Tillman et al. (1991), pp. 34-50.

Berlo, D.K. (1960), *The process of communication: An introduction to theory and practice.* Holt, Rinehart & Winston. New York.

Bernstein, H. (1979), African peasantries: A theoretical framework. In: *Journal of Peasant Studies*, Vol. 6, Nr. 4, pp. 421-443.

Bernstein, H. (1987), *Capitalism and petty commodity production.* DPP working paper No. 3. Open University, Faculty of Technology. Milton Keynes.

Bhaskar, R. (1989), *The possibility of naturalism: A philosophical critique of the contemporary human sciences.* Harvester Wheatsheaf. New York.

Bieleman, J. (1992), *Geschiedenis van de landbouw in Nederland 1500-1950: Veranderingen en verscheidenheid.* Boom Meppel. Amsterdam.

Bink, C.M.M. (1993), Informatiemanagement op melkveebedrijven: Een verkennende studie door middel van workshops. M.Sc. thesis. Department of Farm Management, WAU. Wageningen.

Blanc, M. & G. Allaire (1979), Types d'exploitations et couches sociales dans l'agriculture. In: *Revue Géograpfique des Pyrénees et du Sud-Quest*, Tome 50, Fasc. 2, pp. 343-369, Toulouse.

Blokker, K.J. (1984), *Computergesteunde voorlichting: Een decisiegericht voorlichtingskundig onderzoek naar Epipre en andere geautomatiseerde informatiesystemen in de landbouwvoorlichting.* Department of Extension Science, WAU. Wageningen.

Blokker, K.J. (1991), Strategic investment in IT with a view to integrating the marketing column. In: D. Kuiper, & N.G. Röling (eds.) (1991), pp. 82-90.

Boland, R.J. (1987), The in-formation of information systems. In: R.J. Boland & R.A. Hirschheim (eds.) (1987), pp. 363-379.

Boland, R.J. & R.A. Hirschheim (eds.) (1987), *Critical issues in information systems research*. J. Wiley & Sons. Chichester.

Bolhuis, E.E. & J.D. van der Ploeg (1985), *Boerenarbeid en stijlen van landbouwbeoefening: Een socio-economisch onderzoek naar de effekten van incorporatie en institutionalisering op agrarische ontwikkelingspatronen in Italië en Peru*. Leiden Development Studies. Leiden.

Bos, J.Th.M. (1989), Privatization and reorganization of the Dutch Agricultural Extension Service. In: *Agrarische Voorlichting*, Jaargang 1, Nr. 5, pp. 2-7. (special translated reprint).

Bosman, J., E, Hollander, P. Nelissen, K. Renckstorf, F. Wester & C. Van Woerkum (1989), *Het omgaan met kennis - en de vraag naar voorlichting: Een multidisciplinair theoretisch referentiekader voor empirisch onderzoek naar de vraag naar voorlichting*. Instituut voor Toegepaste Sociale Wetenschapppen, Katholieke Universiteit Nijmegen. Nijmegen.

Bosman, A. & H.G. Sol (1985), Knowledge representation and information systems design. In: L.B. Methlie & R.H. Sprague (eds.) (1985), *Proceedings of the IFIP WG 8.3 working conference on knowledge representation for Decision Support Systems*. pp. 81-91. Elsevier North-Holland. Amsterdam.

Bosman, J., E, Hollander, P. Nelissen, K. Renckstorf, R. Staatsen, F. Wester & C. Van Woerkum (1990), De vraag naar voorlichting: Een becommentarieerde samenvatting van 'Het omgaan met kennis en de vraag naar voorlichting'. In: K. Renckstorf & C.M.J. Van Woerkum (eds.) (1990), pp. 11-34.

Bots, J.M. & E. van Heck (1989), Besturingsmodel, informatiemodel, informatiesystemen: Enige kanttekeningen bij de informatisering van primaire agrarische bedrijven. In: *Agro-Informaticareeks*, Nr. 3, pp. 127-140. VIAS. Wageningen.

Bots, J.M., van Heck, E., Van Swede, V. and Simons, J.L. (1990), *Bestuurlijke Informatiekunde; Een praktisch studie- en handboek voor de mondige gebruiker van informatiesystemen*. Cap Gemini Publishing/Pandata B.V. Rijswijk.

Bourdieu, P. (1981), Men and machines. In: Knorr-Cetina, K.D. & A.V. Cicourel (eds.) (1981), pp. 304-317.

Bourdieu, P. (1984), *Distinction: A social critique of the judgement of taste*. Harvard University Press. Cambridge.

Bourdieu, P.(1990), *The logic of practice*. Polity Press. Cambridge

Bouwman H. & N. Jankowski (eds.) (1989), *Interactieve media op komst*. Otto Cramwinckel Uitgever. Amsterdam.

Bouwman, H. & R. Veneboer (1989), Videotex in de huiskamer? In: H. Bouwman & N. Jankowski (eds.) (1989), pp. 77-86.

Bouwman, H., P. Nelissen & M. Vooijs (eds.) (1991), *Tussen vraag en aanbod: Optimalisering van de informatievoorziening*. Otto Cramwinckel Uitgever. Amsterdam.

Box, L. (1981), How does sociology apply? Over kennis, onmacht, rede en verbeelding in de sociologie. Lecturing paper. Department of Sociology of Rural Development, WAU. Wageningen.

Box, L. (1990), Agrarian knowledge networks: A conceptualization. In: L. Box (ed.) (1990), *From common ignorance to shared knowledge: Knowledge networks in the Atlantic Zone of Costa Rica*. Wageningen Studies in Sociology Nr. 28. WAU. Wageningen. pp. 1-7.

Box, L. (1992), Moving downstream upwards: Dilemmas in Dutch research on agriculture in the tropics. Address given at the 1992 annual meeting of the German council for tropical and subtropical agricultural research, Bonn, 12-2-1992. In: *Informatie Nr.9*. Voorlichtingsdienst Ontwikkelingssamenwerking. The Hague.

Brands, A., W. Hanekamp, H. Paulissen & E. van Rijssel (1987), Informatiemodellen voor land- en tuinbouwbedrijven. In: *Agro-Informaticareeks*, Nr. 1, pp. 16/1-16/9. VIAS. Wageningen.

Brunt, D. (1992), *Mastering the struggle: Gender actors and agrarian change in a Mexican ejido*. CEDLA Latin America studies Nr. 64. CEDLA. Amsterdam.

Bullinger, H.J. & B. Shackel (eds.) (1987), *Proceedings of the second IFIP conference on human-computer interaction*. September 1-4, 1987. Stuttgart. Elsevier North-Holland. Amsterdam.

Burt, R. (1980), Models of network structure. In: *Annual Review of Sociology*, Vol. 6, pp. 79-141.

CAB (1986), Commissie Automatisering Bedrijfsvergelijking (CAB), December 1986. Internal document. CAB.

CAB (1988), Commissie Automatisering Bedrijfsvergelijking (CAB), Juli 1988. Internal document. CAB.

Callon, M. (1986a), Some elements of a sociology of translation: Domestication of the scallops and the fishermen of St Brieuc Bay. In: J. Law (ed.) (1986), pp. 196-233.

Callon, M. (1986b), The sociology of an actor-network: The case of the electric vehicle. In: Callon, M., J. Law & A. Rip (eds.) (1986), pp. 19-34.

Callon, M., J. Law & A. Rip (1986), How to study the force of science. In: Callon, M., J. Law & A. Rip (eds.) (1986), pp. 3-18.

Callon, M., J. Law & A. Rip (eds.) (1986), *Mapping the dynamic of science and technology: Sociology of science in the Real World*. Macmillan. London.

Castillo, G.T. (1983), Technology transfer in an imperfect world. Lecture delivered as recipient of the Honorary Degree of Doctor of Agricultural Sciences at WAU. Wageningen.

CLO (1988), Informaticabeleid: Evaluatie en vooruitzichten land- en tuinbouw na 1988. Centrale Landbouw Organisaties. The Hague.

Chambers, R. (1983), *Rural development: Putting the last first.* Longman. London.

Chambers, R., A. Pacey & L.A. Thrupp (eds.) (1989), *Farmer first: Farmer innovation and agricultural research.* Intermediate Technology Publications. London.

Chayanov, A.V. (1966), *The theory of peasant economy.* (Edited by D. Thorner, B. Kerblay & R.E.F. Smith). Irwin. Homewood.

Checkland, P.B. (1978), The origins and nature of 'hard' systems thinking. In: *Journal of Applied Systems Analysis*, Vol. 5, pp. 99-110.

Checkland, P.B. (1981), *Systems thinking, systems practice.* J. Wiley & Sons. Chichester.

Checkland, P.B. (1985), From optimizing to learning: A development of systems thinking for the 1990's. In: *Journal of the Operational Research Society*, Vol. 36, No. 9, pp. 757-767.

Checkland, P.B. (1988), Soft systems methodology: An overview. In: *Journal of Applied Systems Analysis*, Vol. 15, pp. 27-30.

Checkland, P.B. & L. Davies (1986), The use of the term 'Weltanschauung' in soft systems methodology. In: *Journal of Applied Systems Analysis*, Vol. 13, pp. 109-115.

Chen, L. (1987), The role of Speech Act Theory in systems development. M.Sc. thesis. London School of Economics. London.

Churchman, C.W. (1971), *The design of inquiring systems.* Basic Books. New York.

Churchman, C.W. (1979), *The systems approach and its enemies.* Basic Books. New York.

Clarke, B. & P.N. Finlay (1989), A typology of Decision Support Systems. In: *Journal of Applied Systems Analysis*, Vol. 16, pp. 89-98.

Cohen, M.D., J.G.. March & J.B. Olson (1972), A garbage can model of organizational choice. In: *Administrative Science Quarterly*, Vol. 17. Nr. 1, pp. 1-25.

Contractor, N.S. & E.M. Eisenberg (1990), Communication networks and new media in organizations. In: J. Fulk & C.W. Steinfield (eds.) (1990), pp. 143-172.

Cristis, J. (1985), Technologiektitiek: Een confrontatie tussen Ullrich en Habermas. In: *Krisis 20*, september 1985, pp. 30-51.

Crehan, K. & A. Von Oppen (1988), Understandings of 'development': An arena of struggle. The story of a development project in Zambia. In: *Sociologia Ruralis*, Vol. XXVIII, No. 2-3, pp. 113-145.

Davis, G.B. & M.H. Olson, (1985), *Management information systems: Conceptual foundations, structure and development.* McGraw-Hill Book Company. New York.

Daft, R.L. & K.E. Weick (1984), Toward a model of organizations as interpretation systems. In: *Academy of Management Review*, Vol. 9, No. 2, pp. 284-295.

Damoiseaux, V., M. Van Dongen, F.M. Gerards, H. Ten Have, G.J. Kok, F. Nijhuis, T. Oostveen & N.K. de Vries (1987), *Gezondheidsvoorlichting en -opvoeding: Van analyse tot effecten.* Van Gorcum. Assen/Maastricht.

Darre, J.P. (1985), *La parole et la technique, l'univers de pensée des éleveurs du ternois.* L'Harmattan. Paris.

De Bruin, R. & J.D. Van der Ploeg (1991), *Maat houden: Bedrijfsstijlen en het beheer van natuur en landschap in de Noordelijke Friese Wouden en het Zuidelijk Westerkwartier.* Bos en Landschapsbouw Friesland en Groningen/Department of Sociology of Rural Development, WAU. Wageningen.

De Haan, H.J. & A.T.J. Nooij (1985), Rural sociology in the Netherlands: Developments in the seventies. In: *The Netherlands Journal of Sociology*, Vol. 2, Nr. 1, pp. 51-62.

De Jager, D. (1988), Farm management systems: Decision support for the modern pig farmer. In: A. Hoogerbrugge, E.W. Brascamp & A.P. Barten (eds.) (1988), *Heart of technology: Computerization and quality control in pig and poultry production. Proceedings of the international congress held at the occasion of the International Tradeshow Intensive Animal Production*, November 14-15, 1988. Utrecht. pp. 51-60. VIV-Europe. Utrecht.

De Janvry, A. (1981), *The agrarian question and reformism in Latin America.* The John Hopkins University Press. Baltimore/London.

Depla, S. (1987), BemiddelingsconceptIMGO-Landbouw: Een poging tot rekonstruktie. Wetenschapswinkel, WAU. Wageningen.

Derrida, J. (1976), *Of grammatology.* The John Hopkins University Press. Baltimore/London.

Dervin, B. (1981), Mass communication: Changing conceptions of the audience. In: R.E. Rice & W.J. Paisley (eds.) (1981), *Public communication campaigns.* pp. 71-88. Sage Publications. Beverly Hills.

Dervin, B. (1983), Information as a user construct: The relevance of perceived information needs to synthesis and interpretation. In: S.A. Ward & L.J. Reed (eds.) (1983), *Knowledge, structure and use: Implications for synthesis and interpretation.* pp. 153-183. Philadelphia.

Dervin, B. (1991), Information as non-sense; information as sense: The communication technology connection. In: H. Bouwman, P. Nelissen & M. Vooijs (eds.) (1991), pp. 44-59.

De Valk, P. & B.M.C. Sibanda (1986), About pigs? Decisions, outcomes and project planning. In: *Public Administration and Development*, Vol 6, Nr. 4, pp. 411-423.

De Visser, P. & R.A. Hilhorst (1990), Informatie technologie in de akkerbouw: Status en de gewenste en verwachte ontwikkelingen (concept werkdocument). Agrimathica. Veenendaal.

De Vries, P. (1992), A research journey: On actors, concepts and the text. In: Long, N. & A. Long (eds.) (1992), pp. 47-84.

De Vries, P. (1992) *Unruly clients: A study of how bureaucrats try and fail to transform gatekeepers, communists and preachers into ideal beneficiaries.* Department of the Sociology of Rural Development, WAU. Wageningen.

Dissanayake, W. (1992), Knowledge, culture, and power: Some theoretical issues related to the agricultural knowledge and information system framework. In: *Knowledge and Policy: The international Journal of Knowledge Transfer and Utilization*, Vol. 5, No. 1 (Spring 1992), pp. 65-76.

Durkheim, E. (1966), *The rules of sociological method.* The Free Press. New York.

Elias, N. & J.L. Scotson (1976), *De gevestigden en de buitenstaanders: Een studie van de spanningen en machtsverhoudingen tussen twee arbeidersbuurten.* Het Spectrum. Utrecht/Antwerpen.

Engel, P.G.H. (1989a), Kennis- en informatiegebruik door bedrijfsvoorlicht(st)ers: Uitgangspunt voor kennismanagement. In: *Agrarische Voorlichting*, Jaargang 1, Nr. 6/7, pp. 27-30.

Engel, P.G.H. (1989b), Building upon diversity: A role for information technology in knowledge management for agricultural production. Paper presented at the European Seminar on Knowledge Management and Information Technology, November 23-24, 1989. Wageningen.

Engel, P.G.H. (1990), Knowledge management in agriculture: Building upon diversity. In: *Knowledge in Society: The international journal of knowledge transfer*, Vol. 3, No. 3 (Fall 1990), pp. 28-35.

Engel, P.G.H., A. De Groot & S. Seegers (1990), RAAKS; Rapid Appraisal of Agricultural Knowledge Systems. Draft manual, version.3.2. Department of Extension Science, WAU. Wageningen.

Engel, P.G.H. & S. Seegers (1991), Basic configurations in agricultural technology systems. In: H.J. Tillmann et al. (1991), pp. 353-358.

Engel, P.G.H. & M. Salomon (1993), Rapid Appraisal of Agricultural Knowledge Systems: RAAKS. Draft manual, version 4.2. Department of Extension Science, WAU. Wageningen.

Engel, P.G.H. (forthcoming), *Knowledge management in agriculture.* Ph.D. thesis. Department of Extension Science, WAU. Wageningen.

Evans-Pritchard, E.E. (1950), *Witchcraft, oracles and magic among the Azande.* Oxford University Press. Oxford.

Fayol, H. (1949), *General and industrial management.* Pitman & Sons. London.

Feuer, L.S. (1954), Causality in social sciences. In: *Journal of Philosophy*, Vol. 51, No. 23 (November), pp. 681-695.

Feyerabend, P. (1975), *Against method: Outline of an anarchistic theory of knowledge.* Bristol.

Findler, N.V. & B. Meltzer (eds.) (1971), *Artificial intelligence and heuristic programming.* Edinburgh University Press. Edinburgh.

Finkelstein, C. (1989), *An introduction to Information Engineering: From strategic planning to information systems.* Addison-Wesley Publishing Company. Singapore.

Finlay, P.N. & M. Forghani (1987), The concept of Management Intelligence Systems. In: *Journal of Applied Systems Analysis*, Vol. 14, pp. 41-51.

Fishbein, M. & I. Ajzen (1975), *Belief, attitude, intention and behaviour: An introduction to theory and research.* Addison-Wesley. Reading.

Forrester, J.W. (1971), *World Dynamics.* Wright-Allen. Cambridge.

Foucault, M. (1974), *The order of things: An archeology of the human sciences.* Tavistock Publications. London.

Freeman, L.C. (1979), Centrality in social networks: Conceptual clarification. In: *Social Networks, an international journal of structural analysis*, Vol. 1, pp. 215-239.

Fresco, L. (1984), *Cassava and shifting cultivation; A systems approach to agricultural technology development.* Royal Tropical Institute. Amsterdam.

Friedmann, H. (1980), Household production and the national economy: Concepts for the analysis of agrarian formations. In: *Journal of Peasant Studies*, Vol. 7, Nr. 2, pp. 158-184.

Frissen, V. (1991), Heavy viewing as social action. Paper presented at SOMMATIE '91, March 19-20, 1991. Veldhoven.

Frouws, J. & J.D. van der Ploeg (1988), *Automatisering in land- en tuinbouw: Een agrarisch sociologische analyse.* Wageningen Studies in Sociology Nr. 22. WAU. Wageningen

Fuenmayor, R. & H. López-Garay (1991), The scene for interpretative systemology. In: *Systems Practice*, Vol 4, No. 5, pp. 401-418.

Fulk, J., J. Schmitz & C.W. Steinfield (1990), A social influence model of technology use. In: J. Fulk & C.W. Steinfield (eds.) (1990), pp. 117-140.

Fulk, J. & C.W. Steinfield (eds.) (1990), Organizations and communication technology. Sage. Newbury Park/London

Gadamer, H.G.(1975), *Truth and method.* Sheed and Ward. London.

Gäfgen, G. (1980), Formale Theorie des strategischen Handelns (1971). In: H. Lenk (ed.) (1980), *Handlungstheorien - interdisziplinär.* Band 1. pp. 249-302. Wilhelm Fink Verlag. München.

Garfinkel, H. (1967), *Studies in ethnomethodology.* Prentice-Hall. Englewood Cliffs.

Geuze, M.C. (1991), Agrarisch IT-beleid in de jaren negentig. In: *Agro-informaticareeks*, Nr. 5, pp. 134-143. VIAS. Wageningen.

Gibbon, P. & M. Neocosmos (1985), Some problems in the political economy of 'African socialism'. In: H. Bernstein & B.K. Campbell (eds.) (1985), *Contradictions of accumulation in Africa: Studies in economy and state.* pp. 153-206. Sage Publications. Beverly Hills.

Giddens, A. (1976), *New rules of sociological method: A positive critique of interpretative sociologies.* Hutchinson & Co. London.

Giddens, A. (1979), *Central problems in social theory.* Macmillan. London.

Giddens, A. (1984), *The constitution of society: Outline of the theory of structuration.* Polity Press. Cambridge.

Giddens, A. (1985), Structuratietheorie en empirisch onderzoek. Lecture at Wageningen Agricultural University (27-4-1984). In: Munters, Q.J. et al. (1985), p.27-56.

Giddens, A. (1987), Reason without revolution? Habermas's theory of communicative action. In: A. Giddens (1987), *Social theory and modern sociology.* pp. 225-252. Polity Press. Cambridge.

Gilbert, G.N. & M. Mulkay (1984), *Opening Pandora's box: A sociologist's analysis of scientist's discourse.* Cambridge University Press. Cambridge.

Gilbreth, F.B. (1911), *Motion study: A method of increasing the efficiency of the workman.* D. van Nostrand. Princeton.

Gilbreth, F.B. (1914), *Primer of scientific management.* Constable & Company. London.

Gluckman, M. (1961), Ethnographic data in British social anthropology. In: *Sociological Review (New Series)*, Vol. 9, No. 1, pp. 5-17.

Gödel, K. (1962), *On formally undecidable propositions.* Basic Books. New York. (Translation of: K. Gödel (1931), Über formal unentscheidbare Sätze der Principia Mathematica und verwandter Systeme, I. In: *Monatshefte für Mathematik und Physik*, 38, pp. 173-198.)

Goffman, E. (1959), *The presentation of self in everyday life.* Doubleday. New York.

Good, I.J. (1969), Gödel's theorem is a red herring. In: *British Journal for the Philosophy of Science*, Vol. 19, Nr. 4, pp. 357-358.

Gorry, G.A. & M.S. Scott Morton (1971), A framework for Management Information Systems. In: *Sloan Management Review*, Vol 13, Nr. 1 (Fall 1971), pp. 55-70.

Gould, J.D. (1987), How to design usable systems. In: H.J. Bullinger & B. Shackel (eds.) (1987), pp. xxxv-xli.

Granovetter, M.S. (1973), The strength of weak ties. In: *American Journal of Sociology*, Vol. 78, No. 6, pp. 1360-1380.

Habermas, J. (1970a), On systematically distorted communication. In: *Inquiry*, Vol 13, Nr. 3, pp. 205-218.

Habermas, J. (1970b), Towards a theory of communicative competence. In: *Inquiry*, Vol. 13, Nr. 4, pp. 360-375.

Habermas, J. (1971), Knowledge and human interest: A general perspective. Appendix in: J. Habermas (1971) *Knowledge and human interest.* pp. 301-317. Beacon Press. Boston.

Habermas, J. (1973), *Theory and practice.* Beacon Press. Boston.

Habermas, J. (1981a), *Theorie des kommunikativen Handelns, Band 1: Handlungsrationalität und gesellschaftliche Rationalisierung.* Suhrkamp Verlag. Frankfurt am Main.

Habermas, J. (1981b), *Theorie des kommunikativen Handelns, Band 2: Zur Kritik der funktionalistischen Vernunft.* Suhrkamp Verlag. Frankfurt am Main.

Hamilton, N.A. (1990), Knowledge systems and the development of computer programmes for use by farmers: Towards a new development process. An analysis by case study of WHEAT COUNSELLOR (...) and WHEATMAN (...). M.Sc. thesis. Department of Extension Science, WAU. Wageningen.

Harrington, J. (1991), *Organizational structure and information technology*. Prentice-Hall. London.

Havelock, R.G. (1969), *Planning for innovation through dissemination and utilization of knowledge*. Institute of Social Research, University of Michigan. Ann Arbor.

Havelock, R.G. (1986a), Modelling the knowledge system. In: G.M. Beal, W. Dissanayake & S. Konoshima (eds.) (1986), pp. 77-104.

Havelock, R.G. (1986b), Linkage: Key to understanding the knowledge system. In: G.M. Beal, W. Dissanayake & S. Konoshima (eds.) (1986), pp. 211-244.

Heijdra, H. (1989), Social encounters and interfaces between farmers and intervening actors: The emergence of local organization in Western Mexico. In: Long, N. (ed.) (1989b), pp. 53-102.

Hendriks, Th.H.B. (1990), Operationele Research. In: *Agro Informatica*, Jaargang 3, Nr. 2, pp. 7-12.

Herik, H.J. van den (1988), *Informatica en het menselijk blikveld*. Inaugural address. Faculty of General Sciences, Limburgh State University. Maastricht.

Hilhorst, R.A. & P. de Visser (1991a), Post-INSP onderzoek 'Inventarisatie en analyse akkerbouw' (beleidsnotitie). Agrimathica. Veenendaal.

Hilhorst, R.A. & P. de Visser (1991b), Post-INSP onderzoek 'Inventarisatie en analyse pluimvee' (beleidsnotitie). Agrimathica. Veenendaal.

Hindess, B. (1986), 'Interests' in political analysis. In: J. Law (ed.) (1986), pp. 112-131.

Hofman, H. & J. van Laar (1990), Coöperatief agrarisch netwerk Oost-Nederland CANON (verslag proeffase). CANON. Lochem.

Hofstadter, D.R. (1979), *Gödel, Escher, Bach: An eternal golden braid*. Basic Books. New York.

Hofstede, G.J. (1990a), *Datamodel en database*. Coutinho. Muiderberg.

Hofstede, G.J. (1990b), Gebruikersvriendelijkheid: Druk op de muis of kat in de zak? In: *Agro Informatica*, Jaargang 3, Nr. 3, pp. 4-7.

Hofstede, G.J., K.J. Leutscher, G. Trip & G.W. Ziggers (1991), OMIS: Informatiesystemen voor operationele en taktische besturing. Conference paper.

Hofstede, G.J. (1992), *Modesty in modelling: On the applicability of interactive planning systems, with a case study in pot plant cultivation*. Thesis Publishers. Amsterdam.

Hofstee, E.W. (1985), *Groningen van grasland naar bouwland, 1750-1930: Een agrarisch-economische ontwikkeling als probleem van sociale verandering*. PUDOC Wageningen. Wageningen.

Horkheimer, M. (1977), *Kritische Theorie: Eine Dokumentation*. S. Fischer Verlag. Frankfurt am Main.

Hoselitz, B.F. (1962), *Sociological aspects of economic growth*. The Free Press of Glencoe. New York.

Huber, G.P. (1990), A theory of the effects of advanced information technologies on organizational design, intelligence, and decision making. In: J. Fulk & C.W. Steinfield (eds.) (1990), pp. 237-274.

Huirne, R.B.M. (1990), *Computerized management support for swine breeding farms*. Ph.D. thesis. Department of Farm Management, WAU. Wageningen.

Huizer, G. (1973), *A research on social practice: Some ethical considerations on research in the Third World*. Occasional papers ISS, No. 34. ISS. The Hague.

Hulme, D. (1991), Agricultural technology development, agricultural extension and applied social research, In: *Sociologia Ruralis*, Vol. XXX, No. 3/4, pp. 323-335

Husserl, E. (1962), *Phänomenologische Psychologie: Vorlesungen Sommersemester 1925*. Herausgegeben von W. Biemel. Martinus Nijhof. The Hague.

IBM (1988), *Boer en tuinder op weg naar managementsystemen*. IBM. Eindhoven.

ILEIA (1989), *Proceedings ILEIA workshop on Operational Approaches for Participatory Technology Development in Sustainable Agriculture*. ILEIA. Leusden.

INSP-LO (1987), Landbouw 2000 en informatietechnologie (concept). INSP-LO. Wageningen.

INTERMATION (1989), Functionele specifikaties uitbreiding INFOTUIN. INTERMATION. Gouda.

Jackson, M.C. (1982), The nature of 'soft' systems thinking: The work of Churchman, Ackoff and Checkland. In: *Journal of Applied Systems Analysis*, Vol. 9, pp. 17-29.

Jackson, M.C. (1985), Social systems theory and practice: The need for a critical approach. In: *International Journal of General Systems*, Vol. 10, pp. 135-151.

Janis, I.L. & L. Mann (1977), *Decision making: A psychological analysis of conflict, choice and commitment*. Free Press. New York.

Jenkins, G.M. (1969), The systems approach. In: *Journal of Systems Engineering*, Vol. 1, No. 1, pp. 3-49.

Jones, E.E. & Davis, K.E. (1965), From acts to dispositions: The attribution process in person perception. In: L. Berkowitz (ed.), *Advances in experimental social psychology*, Vol. 2, pp. 219-266. Academic Press. New York.

Jörgensen, A.H. (1987), The trouble with UNIX MAIL: Initial learning and experts' strategies. In: H.J. Bullinger & B. Shackel (eds.), pp. 847-854.

Jorna, R.J. (1992a), Filosofische achtergronden. In: R.J. Jorna & J.L. Simons (eds.) (1992), pp. 29-49.

Jorna, R.J. (1992b), Het representeren van kennis en kennisrepresentaties. In: R.J. Jorna & J.L. Simons (eds.) (1992), pp. 176-200.

Jorna, R.J. & J.L. Simons (eds.) (1992), *Kennis in organisaties: Toepassingen en theorie van kennissystemen.* Coutinho. Muiderberg.

Kaimowitz, D. (1990), Moving forces: External pressure and the dynamics of technology systems. In: *Knowledge in Society: The international journal of knowledge transfer*, Vol. 3, No. 3. (Fall 1990), pp. 36-43.

Kay, R.D. (1986), *Farm management; Planning, control and implementation.* McGraw-Hill. New York.

Keen, P.W.G. (1976), Computer systems for top managers: A modest proposal. In: *Sloan Management Review*, Vol. 18, No. 1 (Fall 1976a), pp. 1-17.

Kelley, H.H. (1973), The process of causal attribution. In: *American Psychologist*, Vol. 28, No. 2 (February), pp. 107-128.

Keuning, D. and Eppink, D.J. (1982), *Management en Organisatie.* Stenfert Kroeze. Leiden.

King, R., T. Cross, C. Dobbins & E. Fuller (1992), Workshops for identifying farm information system needs. In: *Proceedings of the 4th international congress for computer technology in agriculture.* Versailles, France, June 1-3. pp. 211-214.

Klein, G.C. (1982), Let's not be lecturing on navigation while the ship is going down: On the creation of public interest sociology. In: *The American Sociologist*, Vol. 17, No. 3 (August), pp. 120-133.

Kline, S.J. & N. Rosenberg (1986), An overview of innovation. In: R. Landau & N. Rosenberg (eds.) (1986), *The positive sum strategy: Harnessing technology for economic growth.* pp. 275-305. National Academic Press. Washington.

Klink, J.P.M. (1990a), Voorlopige eindrapportage onderzoek 'Post-INSP' onderdeel 'inventarisaties/analyses varkenshouderij'. Agritect Advies. Gouda.

Klink, J.P.M. (1990b), De status en de gewenste en verwachte ontwikkelingen op informatietechnologie-gebied voor de melkveehouderij (concept werkdocument). Agritect Advies. Gouda.

Klink, J.P.M. (1990c), Post-INSP Hoofdlijnen (concept). Agritect Advies. Gouda.

Klink, J.P.M. (1991a), Hoofdlijnen post-INSP-beleid: Van informaticastimulering naar informatiebeleid. Agritect Advies. Gouda.

Klink, J.P.M. (1991b), Post-INSP onderzoek 'Melkveehouderij' (beleidsnotitie). Agritect Advies. Gouda

Klink, J.P.M. (1991c), Post-INSP onderzoek 'Varkenshouderij' (beleidsnotitie). Agritect Advies. Gouda

Klink, J.P.M. (1991d), Post-INSP onderzoek 'Voorlichting en begeleiding' (thema-notitie). Agritect Advies. Gouda

Klink, J.P.M. (1991e), Post-INSP onderzoek 'Standaardisatie en uniformering' (thema-notitie). Agritect Advies. Gouda

Knorr-Cetina, K.D. (1981a), *The manufacture of knowledge: An essay on the constructivist and contextual nature of science.* Pergamon Press. Oxford/New York.

Knorr-Cetina, K.D. (1981b), The micro-sociological challenge of macro-sociology: Towards a reconstruction of social theory and methodology. In: K.D. Knorr-Cetina & A.V. Cicourel (eds.) (1981), pp. 1-47.

Knorr-Cetina, K.D. (1988), The micro-social order. Towards a reconception. In: Fielding, N.G. (ed.), *Actions and structure: Research methods and social theory.* pp. 21-53. Sage. London.

Knorr-Cetina, K.D. & A.V. Cicourel (eds.) (1981), *Advances in social theory and methodology. Toward an integration of micro- and macro-sociologies.* Routledge & Kegan Paul. London.

Koelen, M.A. (1988), *Tales of logic: A self-presentational view on health-related behaviour.* Ph.D. thesis. Department of Extension Science, WAU. Wageningen.

Kolb, D.A. (1984), *Experiential learning: Experience as the souce of learning and development.* Prentice-Hall. Englewood Cliffs.

Koning, N.B.J. (1982), Agrarische gezinsbedrijven en industrieël kapitalisme. In: *Tijdschrift voor Politieke Economie*, Jaargang 6, Nr. 1, pp. 35-66.

Koningsveld, H. (1980), Voorlichting: Manipulatie of kritiek? In: *Tijdschrift voor Agologie*, Jaargang 9, Nr. 2, p.71-88.

Koningsveld, H. & J. Mertens (1986), *Communicatief en strategisch handelen: Inleiding tot de handelingstheorie van Habermas.* Coutinho. Muiderberg.

Koningsveld, H. (1990a), Kennissystemen in de voorlichtingskunde. Discussion paper. Department of Applied Philosophy, WAU. Wageningen.

Koningsveld, H. (1990b), Het kennissysteem in de landbouw. Discussion paper. Department of Applied Philosophy, WAU. Wageningen.

Kotler, P. (1985), *Marketing for non-profit organizations.* Aldine. Chicago.

Krabbenborg, H.A. (1982), Computerprogramma's voor deelboekhoudingen rundveehouderij. In: *Bedrijfsontwikkeling*, Jaargang 13, Nr. 6 (juni), pp. 538-540

Kranendonk, A. (1986), *Een socio-technische aanpak: Automatisering voor de rechter hersenhelft.* In: Methodieken voor informatiesysteemontwikkeling (NGI-rapport 3a). NGI. Amsterdam.

Kristen, G. (1991), Realiteit weergeven via objectmodellen: Een praktische methode voor object-georiënteerd systeemontwikkelen. In: *Computable*, Jaargang 24, Week 3, pp. 29-31.

Kruiter, A.H. & M.J.F. Langen (1988), VITAK bekeken: Een tussentijdse evaluatie van een videotex project. M.Sc. thesis. Department of Extension Science, WAU. Wageningen.

Kuhn, T.S. (1970), *The structure of scientific revolutions.* University of Chicago Press. Chicago.

Kuiper, D. & N.G. Röling (eds.) (1991), *The edited proceedings of the European Seminar on Knowledge Management and Information Technology.* Department of Extension Science, WAU. Wageningen.

Kuitenbrouwer, J.B.W. (1975), *Science and technology: For or against the people.* Occasional papers ISS, No. 49. ISS. The Hague.

Kunneman, H. (1983), *Habermas' theorie van het communicatieve handelen: Een samenvatting.* Boom Meppel. Amsterdam.

Latour, B. (1986), The powers of association. In: J. Law (ed.) (1986), pp. 264-280.

Latour, B. (1987), *Science in Action.* Open University Press. Milton Keynes.

Landbouwschap (1991), Resultaten Post-INSP-onderzoek (concept reactie). Landbouwschap. The Hague.

Landry, M., D. Pascot & D. Briolat (1985), Can DSS evolve without changing our view of the concept "problem"? In: *Decision Support Systems*, Vol. 1, Nr. 1, pp. 25-36.

Layder, D. (1981), *Structure, interaction and social theory.* Routledge & Kegan Paul. London.

Law, J. (ed.) (1986), *Power, action and belief: A new sociology of knowledge?* Routledge & Kegan Paul. Boston and Henley.

Leeuwis, C. (1989b), *Marginalization Misunderstood: Different patterns of farm development in the West of Ireland.* Wageningen Studies in Sociology Nr. 26. WAU. Wageningen.

Leeuwis, C. (1989a), Voorlichtingskunde en informatie-technologie; de 'gebruiker' centraal. In: *Agro-Informaticareeks*, Nr. 3, pp. 59-70.

Leeuwis, C. (1990), User-interfaces breed gedefinieerd. In: *Agro Informatica*, Jaargang 3, Nr. 3, pp. 12-16.

Leeuwis, C. (1990b), Computer-ondersteunde bedrijfsvergelijking in de komkommerteelt: Concept verslag van een onderzoek in opdracht van, en in samenwerking met, de Stookkomkommer Studieclub Brabant/Limburg. Department of Extension Science, WAU. Wageningen.

Leeuwis, C., N. Long & M. Villarreal (1990), Equivocations on knowledge systems theory: An actor oriented critique. In: *Knowledge in Society: The International Journal of Knowledge Transfer*, Vol. 3, No. 3 (Fall 1990), pp. 19-27.

Leeuwis, C. & Arkesteyn, M. (1991), Planned technology development and local initiative: Computer supported enterprise-comparisons among Dutch horticulturists. In: *Sociologia Ruralis*, Vol. XXXI, No. 2/3, pp. 140-161.

Leeuwis, C. (1991a), From electronic to social interfaces: Towards extension-based characterizations in relation to IT-applications. In: D. Kuiper & N.G. Röling, (eds.) (1991), pp. 107-116.

Leeuwis, C., N.A. Hamilton & G. Moorman (1991), Developing extension support systems in agriculture. In: D. Kuiper & N.G. Röling, (eds.) (1991), pp. 165-174.

Leeuwis, C. (1991b), Naar een gebruikersgestuurde ontwikkeling van software. In: *Agro Informatica*, Jaargang 4, Nr. 4, pp. 5-9.

LEI/CBS (1989), Tuinbouwcijfers 1988. LEI/CBS. The Hague/Voorburg.

LEI/CBS (1991), Landbouwcijfers 1990. LEI/CBS. The Hague/Voorburg.

Lévi-Strauss, C. (1972), *Structural Anthropology.* Penguin Books Ltd. Harmondsworth.

Long, N. (1977), *An introduction to the sociology of rural development.* Tavistock Publications. London.

Long, N. (1986), Commoditization: Thesis and antithesis. In: N. Long, J.D. van der Ploeg, C. Curtin & L. Box (1986), pp. 8-23.

Long, N. (1989a), Knowledge, networks and power: Discontinuities and accomodities at the interface. Paper presented at the European Seminar on Knowledge Management and Information Technology, November 23-24, 1989. Wageningen.

Long, N. (ed.) (1989b) *Encounters at the interface: A perspective on social discontinuities in rural development.* Wageningen Studies in Sociology Nr. 27. WAU. Wageningen.

Long, N. (1990), From paradigm lost to paradigm regained? The case for an actor-oriented sociology of development. In: *European Review of Latin American and Caribbean Studies*, Vol. 49, December, pp. 3-32.

Long, N., J.D. van der Ploeg, C. Curtin & L. Box (1986), *The commoditization debate: Labour process, strategy and social network.* Wageningen Studies in Sociology Nr. 17. WAU. Wageningen.

Long, N. & A. Long (eds) (1992), *Battlefields of knowledge: The interlocking of social theory and practice in research and development.* Routledge. London and New York.

Long, N. & J.D. van der Ploeg (1989), Demythologizing planned intervention. In: *Sociologia Ruralis*, Vol. XXIX, No. 3/4, pp. 226-249.

Long, N. & J.D. van der Ploeg (1991), Heterogeneity, actor and structure: Towards a reconstitution of the concept of structure. Paper presented to workshop on Relevance, Realism and Choice in Social Development Research, Centre of Developing Area Studies, The University of Hull, January 11-12, 1991. Hull.

Lucas, J.R. (1961), Minds, machines and Gödel. In: *Philosophy*, Vol. 36, Nr. 137, pp. 112-127.

Luhmann, N. (1982), Autopoiesis, Handlung und kommunikative Verständigung. In: *Zeitschrift für Soziologie*, Jg. 11, Heft 4, pp. 366-379.

Luhmann, N. (1984), *Soziale Systeme: Grundriss einer allgemeinen Theorie.* Suhrkamp Taschenbuch Wissenschaft 666. Suhrkamp. Frankfurt am Main.

Luhmann, N. (1986), *Die soziologische Beobachtung des Rechts.* Alfred Metzner Verlag. Frankfurt am Main.

Lundeberg, M., G. Goldkuhl & A. Nilsson (1982), *Systeemontwikkeling volgens ISAC: De ISAC-methodiek.* Samson Uitgeverij. Alphen aan de Rijn.

Lynch, M. (1985), *Art and artifact in laboratory science. A study of shopwork and shoptalk in a research laboratory.* Routledge & Kegan Paul. London.

Lyytinen, K. (1985), Implications of theories of language for information systems. In: MIS Quarterly, Vol. 9, No. 1, pp. 61-74.

Lyytinen, K. (1987) A taxonomic perspective of information systems development: Theoretical constructs and recommendations. In: R.J. Boland & R.A. Hirschheim (eds.) (1987), pp. 3-41.

Lyytinen, K. & H. Klein (1985), Critical social theory of Jürgen Habermas (CST) as a basis for the theory of information systems. In: E. Mumford, R. Hirschheim, G. Fitzgerald & A.T. Wood-Harper (eds.), *Research methods in information systems.* pp. 219-236. Elsevier North-Holland. Amsterdam.

Mainié, P. (1971), *Les capitalisons agricoles en France.* PUF. Paris.

Marglin S.A. (1991a), High-tech agriculture: A systems of knowledge perspective. In: H.J. Tillmann et al. (1991), pp. 80-104.

Marglin S.A. (1991b), Alternative agriculture: A systems of Knowledge approach. In: H.J. Tillmann et al. (1991), pp. 105-126.

Markowitz, H.M. (1959), *Portfolio selection, efficient diversification of investments.* J. Wiley & Sons. New York.

Markus, M.L. (1990), Toward a "critical mass" theory of interactive media. In: J. Fulk & C.W. Steinfield (eds.) (1990), pp. 194-218.

Markus, M.L. & D. Robey (1988), Information technology and organizational change: Causal structure in theory and research. In: *Management Science*, Vol. 34, No. 5, 583-598.

Mars, N.J.I. (1987), Onderzoek van niveau; Kennistechnologie in wording. In: *Informatie*, Jaargang 30, Nr. 2, pp. 84-90.

Martin, J. (1982), *Strategic data planning methodologies.* Prentice-Hall. Englewood Cliffs.

Marx, K. (1973), The eighteenth brumaire of Louis Bonaparte. In: K. Marx & F. Engels (1973), *Selected works (volume 1).* pp. 398-487. Progress Publishers. Moscow.

Marx, K. (1977) *Het kapitaal: Een kritische beschouwing over economie.* De Haan. Haarlem.

Maturana, H.R. (1978), Biology of language: The epistemology of reality. In: G.A. Miller & E. Lenneberg (eds.) (1978), *Psychology and biology of language and thought: Essays in honour of Eric Lenneberg.* pp. 27-64. Academic Press. New York.

Maturana, H.R. (1980), Biology of cognition. In: H.R. Maturana & F.J. Varela (1980), *Autopoiesis and cognition: The realization of the living.* pp. 2-62. Reidel. Dordrecht.

Maturana, H.R. & F.J. Varela (1984), *The tree of knowledge: The biological roots of human understanding.* Shambala. Boston.

Maturana, H.R. & F.J. Varela (1989), *De boom der kennis: Hoe wij de wereld door onze eigen waarneming creëren.* Uitgeverij Contact. Amsterdam.

Mayo, E. (1933), *The human problems of an industrial organization.* Macmillan. New York.

McCarthy, Th. (1978), *The critical theory of Jürgen Habermas*. Hutschinson. London.

Mendras, H. (1970), *The vanishing peasant, innovation and change in French agriculture*. MIT Press. Cambridge.

Ministry of Economic Affairs (1988), Een eerste aanzet: Verslag van een sobere, toekomstgerichte evaluatie van het Informatica Stimulerings Plan (INSP). The Hague.

Mintzberg, H. (1979), *The structuring of organizations*. Prentice-Hall. Englewood Cliffs.

Misset (1989), Boeren contouren: Misset documentatie over markten en media in de landbouw. Misset. Doetinchem.

MLV, Ministry of Agriculture and Fisheries (1984), INSP-LV: Informatica Stimuleringsplan Ministerie van Landbouw en Visserij. MLV. The Hague.

MLV, Ministry of Agriculture and Fisheries (1986), IBV, informatie beleidsplan voorlichting: Enkele zetten vooruit gedacht. MLV. The Hague.

MLV, Ministry of Agriculture and Fisheries (1987a), Handboek methode en technieken voor informatie modellen. Department of Organization and Efficiency in cooperation with James Martin Associates. The Hague.

MLV, Ministry of Agriculture and Fisheries (1987b), Letter of O&S fund to SITU, OS 287, d.d. 9-7-1987. MLV. The Hague.

MLNV, Ministry of Agriculture, Fisheries and Nature Conservation (1989), Structuurnota landbouw. SDU. The Hague.

Moerman, M. (1968), *Agricultural change and peasant choice in a Thai village*. University of California Press. Berkeley/Los Angeles.

Mollinga pp. & J. Mooij (1989), Cracking the code: Towards a conceptualization of the social content of technical artefacts. Technology Policy Group Occasional Paper No. 18. Open University. Milton Keynes.

Moran, T.P. (1981), An applied psychology of the user. In: *ACM Computing Surveys*, Vol. 13, Nr. 1, pp. 1-11.

Morgan, G. (1986), *Images of organization*. Sage. Beverly Hills.

Mumford, E. & D.A. Henshall (1979), *A participative approach to computer system design*. Associated Business Press. London.

Munters, Q.J., E. Meijer, H. Mommaas, H. van der Poel, R. Rosendal & G. Spaargaren (1985), *Anthony Giddens: Een kennismaking met de structuratie theorie*. Wageningen Studies in Sociology Nr. 14. WAU. Wageningen.

Nass, C. & L. Mason (1990), On the study of technology and task: A variable-based approach. In: J. Fulk & C.W. Steinfield (eds.) (1990), pp. 46-67.

NCB (1988), Anonymous internal document without title, reporting on survey among DELAR users.

Nelissen, P. & K. Renckstorf (1991), De vraag naar informatie: Een handelingtheoretisch perspectief voor onderzoek. In: H. Bouwman, P. Nelissen & M. Vooijs (eds.) (1991), pp. 60-70.

Nencel, L. (1992), Feeling gender speak: Sharing space with female prostitutes in Lima Peru. Draft version for article in Critical Anthropology.

Netter, L.N. (1991), Agricultural videotex developments in France. In: D. Kuiper & N.G. Röling (eds.) (1991), pp. 134-140.

Neijens, P. (1989), Intelligentie in databanken: Hulp bij verwerken van informatie. In: H. Bouwman & N. Jankowski (eds.) (1989), pp. 58-66.

Nigten, A. (1987a), Automatisering in de bloembollensektor en de gevolgen voor werknemers. Wetenschapswinkel report Nr. 22. Wetenschapswinkel, WAU. Wageningen.

Nigten, A. (1987b), Automatisering in de loonwerksektor en de gevolgen voor werknemers. Wetenschapswinkel report Nr. 20. Wetenschapswinkel, WAU. Wageningen.

Nielsen, J. & R. Molich (1989), Teaching user-interface design based on usability engineering. In: *ACM SIGCHI bulletin*, Vol. 21, Nr. 1, pp. 45-48.

Nitsch, U. (1991), Computers and the nature of farm management. In: D. Kuiper & N.G. Röling (eds.) (1991), pp. 99-106.

Nooij, A.T.J. (1993), Classificaties in het sociologisch onderzoek. In: *Tijdschrift voor Sociaalwetenschappelijk onderzoek van de Landbouw*, Jaargang 8, Nr. 1, pp. 5-19.

Norusis, M.J. (1986), *SPSS/PC+ advanced statistics*. SPSS Inc. Chicago.

NRLO (1989), Commercialisering van kennis en het functioneren van het landbouwkennissysteem. NRLO-report Nr. 89/32. NRLO. The Hague.

NRLO (1991), Informatietechnologie in de land- en tuinbouw. NRLO-report Nr. 91/3. NRLO. The Hague.

NTS (1988), Without title. Internal document. NTS. Honselersdijk.

NTS (1989), Specificaties teeltvergelijkingsprogramma, 10 april 1989. NTS. Honselersdijk.

NTS (1990a), Verwerkingsprogramma opbrengsten. NTS. Honselersdijk.

NTS (1990b), Verwerkingsprogramma vrije pagina. NTS. Honselersdijk.

NTS (1990c), Invoerprogramma arbeid. NTS. Honselersdijk.

Oliver, P.E., G. Marwell & R. Teixeira (1985), A theory of critical mass. Interdependence, group heterogeneity, and the production of collective action. In: *American Journal of Sociology*, Vol. 91, No. 3, pp. 522-556.

Oonincx, J.A.M. (1982), Waarom falen informatiesystemen nog steeds. Samson. Alphen a/d Rijn.

Ortiz, S. (1967), The structure of decision making. In: R. Firth (ed.), Themes in Economic Anthropology. pp. 191-228. Tavistock Publications. London.

Overbeek, G. & P. Munters (1988), *De komputer gestuurd: Onderzoek naar toepassingen van automatisering in de land en tuinbouw.* Wetenschapswinkel report Nr. 30. Wetenschapswinkel, WAU. Wageningen.

Overbeek, M.M.M. (1992), *Informatietechnologie in de melkveehouderij: Toepassingen en effecten.* Onderzoeksverslag Nr. 99. LEI-DLO. The Hague.

Parsons, T. (1951), *The social system.* Free Press. Glencoe.

Pettigrew, A. (1973), *The politics of organizational decision making.* Tavistock. London.

Petty, R.E. & J.T. Cacioppo (1986), The elaboration likelihood model of persuasion. In: L. Berkowitz (ed.), *Advances in experimental social psychology*, Vol. 19, pp. 123-205. Academic Press. New York.

Pfeffer, J. (1982), *Organizations and organization theory.* Pitman. Marshfield.

Pieters, R.G.M. & W.F. Van Raay (1988), Functions and management of affect: Applications to economic behaviour. In: *Journal of Economic Psychology*, Vol. 9, No. 2, pp. 251-282.

Pieters, R.G.M., & M. Warmerdam, (1991), Affect and communication effectiveness: Differences between consumers and advertisements. Paper presented at the Advanced Research Seminar of the Department of Extension Science, November 6, 1991. Wageningen.

Popper, K. (1972), *Objective knowledge.* Oxford University Press. Oxford.

PTB, (1985), Informatiemodel potplanten (eindverslag van de werkgroep informatiemodel potplanten). PTB. Aalsmeer.

Pijnenburg, L. (1991), De voorlichter: Gesprekspartner, manipulator of functionele actor. In: B. Gremmen & S. Lijmbach (eds.) (1991), *Toegepaste filosofie in de praktijk.* pp. 118-130. Wageningen Studies in Sociology Nr. 32. WAU. Wageningen.

Quade, E.S. & W.I. Boucher (1968), *Systems analysis and policy planning: Applications in defence.* Elsevier. New York.

Quarles van Ufford, P. (1990), Knowledge and ignorance: Integration and segmentation in development policy processes. Paper presented at 14th European Congress of Rural Sociology, July 16-20, 1990. Giessen.

Ramackers G.J. & W.J.J. van der Kuil (1990), Wat is Object-Oriented programmeren? In: *Informatie*, Jaargang 32, Nr. 12, pp. 1024-1029.

Rapoport, A. (1960), *Fights, games and debates.* University of Michigan Press. Ann Arbor.

Raven, P. (1991), Informatiemodel 'Gewasgroei en -ontwikkeling'. In: *Agro Informatica*, Jaargang 4, Nr. 5, pp. 11-16.

RCB Brabant/Limburg (1989), Verslag van de regionale commissie bedrijfsregistratie d.d. 6 juni 1989. RCB Brabant/Limburg.

Renckstorf, K. (1991), Media use as social action. Paper presented at SOMMATIE '91, March 19-20, 1991. Veldhoven.

Renckstorf, K. & C.M.J. van Woerkum (eds.) (1990), *De vraag naar voorlichting.* Instituut voor Toegepaste Sociale Wetenschapppen, Katholieke Universiteit Nijmegen. Nijmegen.

Richards, P. (1985), *Indigenous agricultural revolution.* Hutchinson. London.

Richards, P. (1991), Mende names for rice: Some thoughts on the role of cultural analysis in the elucidation of agricultural knowledge systems. In: H.J. Tillmann et al. (1991), pp. 178-184.

Roep, D. (1988), Stap voor stap of met een sprong: Bedrijfsstrategieën in het landbouwstelsel van Parmigiano Reggiano. M.Sc. thesis. Department of Sociology of Rural Development, WAU. Wageningen.

Roep, D., J.D. Van der Ploeg & C. Leeuwis (1991), *Zicht op duurzaamheid en kontinuïteit: Bedrijfsstijlen in de Achterhoek.* Department of Sociology of Rural Development, WAU. Wageningen.

Roep, D. & J. Roex (1992), *Wikken en wegen: Bedrijfsstijlen en verschillen in stikstofoverschot.* Department of Rural Sociology, WAU. Wageningen.

Roethlisberger, F.J. & W.J. Dickson (1961), *Management and the worker.* Harvard University Press. Cambridge.

Rogers, E.M. (1983), *Diffusion of innovations* (Third edition). The Free Press. New York.

Rogers, E.M. (1986), *Communication technology: The new media in society.* The Free Press. New York.

Rogers, E.M. & D.L. Kincaid (1981), *Communication networks: Toward a new paradigm for research.* The Free Press. New York.

Rohlfs, J. (1974), A theory of interdependent demand for a communication service. In: *The Bell Journal of Economics and Management Science*, Vol. 5, No. 1, pp. 16-37.

Röling, N.G. (1985), Extension science: Increasingly pre-occupied with knowledge systems. In: *Sociologia Ruralis*, Vol. XXV, No. 4/5, pp. 269-290.

Röling, N.G. (1988a), *Extension science: Information systems in agricultural development*. Cambridge University Press. Cambridge.

Röling, N.G. (1988b), Extension, knowledge systems and the research-technology transfer interface. Unpublished manuscript. Department of Extension Science, WAU. Wageningen.

Röling, N.G. (1989), *The agricultural research-technology transfer interface: A knowledge systems perspective*. ISNAR. The Hague.

Röling, N.G. & P.G.H. Engel (1990), IT from a knowledge systems perspective: Concepts and issues. In: *Knowledge in Society: The international journal of knowledge transfer*, Vol. 3, No. 3 (Fall 1990), pp. 6-18.

Röling, N.G. (1991), Farm knowledge, politics permitting. In: H.J. Tillmann et al. (1991), pp. 9-33.

Röling, N.G. (1992a), Man/environment interaction: An exercise in epistimology. First draft. Department of Extension Science, WAU. Wageningen.

Röling, N.G. (1992b), The emergence of knowledge systems thinking: A changing perception of relationships among innovation, knowledge process and configuration. In: *Knowledge and Policy: The international Journal of Knowledge Transfer and Utilization*, Vol. 5, No. 1 (Spring 1992), pp. 42-64.

Röling, N.G. (1992c), Facilitating sustainable agriculture: Turning policy models upside down. Invited paper for: 'Beyond Farmer First: Rural People's Knowledge, Agricultural Research and Extension Practice'. Workshop at the Institute of Development Studies, University of Sussex, October 27-29, 1992, Brighton.

Rommens, J. (1990), Criteria voor de ontwikkeling van voorlichtings ondersteunende systemen. MSc. thesis. Department of Extension Science, WAU. Wageningen.

Rostow, W.W. (1962), *The stages of economic growth: A non-communist manifesto*. Cambridge University Press. Cambridge.

Schaap, L., M.J.W. van Twist & R.J. in't Veld (1990), De eigenwijze samenleving: Sturing van gesloten systemen. In: *Bestuur*, Jaargang 9, Nr. 10, pp. 263-267.

Schiefer, G. (1991), Systems supporting the use of local knowledge. In: D. Kuiper & N.G. Röling (eds.) (1991), pp. 117-123.

Schreurs, E. & P. Vrieler (1988), Arbeid naast het bedrijf in de agrarische sector: Een onderzoek ten behoeve van agrarische jongeren in Noord- en Zuid-Holland. Wetenschapswinkel rapport Nr. 29. Wetenschapswinkel, WAU. Wageningen.

Schrijvers, J. (1991), Dialectics of a dialogical ideal: Studying down, studying sideways and studying up. In: L. Nencel & P. Pels (eds.) (1991), *Constructing knowledge: Authority and critique in social science*. pp. 162-179. Sage. London.

Schrijvers, J. (1992), *De boodschap van het vijfde ontwikkelingsdecennium*. Inaugural address. Institute for Development Research Amsterdam. Amsterdam.

Schutz, A. (1972), *The phenomenology of the social world*. Heinemann Educational Books. London.

Schutz, A. & T. Luckmann (1974), *The structures of the life-world*. Heinemann Educational Books. London.

Scott, R.A. & A.R. Shore (1979), *Why sociology does not apply: A study of the use of sociology in public policy*. Elsevier North-Holland. New York.

Searle, J.R. (1969), *Speech acts: An essay in the philosophy of language*. Cambridge University Press. Cambridge.

Shaner, W.W. et al. (1982), *Farming Systems Research and development: Guidelines for developing countries*. Westview Press. Boulder.

Shneiderman, B. (1980), *Software psychology*. Winthrop Publishing Incorporated. Cambridge.

Shneiderman, B. (1987), *Designing the user-interface: Strategies for effective human-computer interaction*. Addison-Wesley. Reading.

Short, J., E. Williams & B. Christie (1976), *The social psychology of telecommunications*. J. Wiley & Sons. London.

Simon, H.A. (1961), *Administrative behaviour: A study of decision-making processes in administrative organization*. Macmillan. New York.

Simon, H.A. (1977), *The new science of management decision*. Prentice-Hall. Englewood Cliffs.

SITU (1987), Proef en demonstratieprojekt bedrijfsvergelijking in studieclub-verband. SITU. Honselersdijk.

SITU (1989), Bedrijfsvergelijking in studieclubverband, deelprojekt glasgroenten. Verslag 1e fase/Plannen en subsidie-aanvraag 2e fase. (concept). SITU. Honselersdijk.

SITU (1990), Bedrijfsvergelijking in studieclubverband, deelproject glasgroente. Tussenrapportage activiteiten 1989. SITU. Honselersdijk.

SIVA (1988), Toepassingen van informatica in de varkenshouderij: Nu en in de toekomst. Activiteitenplan voor 1989-1991. SIVA. Wageningen.

Slaa, P. (1989), Publieksgerichte video op zoek naar publiek. In: H. Bouwman & N. Jankowski (eds.) (1989), pp. 69-76.

Snel, B. (1992), Dienst Landbouwvoorlichting pakt boerderijautomatisering aan. In: *Agro Informatica*, Jaargang. 5, Nr. 4, pp. 12-14.

Sol, H.G. (1984), *Expertise rond informatiesysteem ontwerp*. Inaugural address. Samson Uitgeverij. Alphen aan den Rijn.

Spaan, J.H. & J.D. Van der Ploeg (1992), *Toppers en tuinders, bedrijfsstijlen in de glastuinbouw: Een verkenning*. Provincie Zuid-Holland/Department of Sociology of Rural Development, WAU. Wageningen.

Stamper, R.K. (1987), Semantics. In: R.J. Boland & R.A. Hirschheim (eds.) (1987), pp. 43-78.

Stamper, R.K. (1988), Analysing the cultural impact of a system. In: *International Journal of Information Management*, Vol. 8, Nr. 2, pp. 107-122.

Stamper, R.K. (1990a), The information profession in the 2000's: New tasks and responsibilities. In: *Informatie*, Jaargang 32, themanummer, pp. 898-909.

Stamper, R.K. (1990b), A sematic analysis of basic concepts. Paper for FRISCO task group of IFIP, WG 8.1, and EC-COTECH project. School of Management Studies. Enschede.

Stamper, R.K. & M. Kolkman (1991), Problem articulation: A sharp-edged soft systems approach. In: *Journal of Apllied Systems Analysis*, Vol. 18, pp. 69-76.

Staring, W.C.H. (1870), *Natuurkunde en volksvlijt van Nederland, strekkende ter verklaring der kaarten voor aardkunde, landbouw, nijverheid, weerkennis en waterstaat*. C.L. Brinkman. Amsterdam.

Steinfield, C.W. (1991), Communicatie via computers binnen organisaties: Theoretische kaders en onderzoeksrichtingen. In: H. Bouwman, P. Nelissen & M. Vooijs (eds.) (1991), pp. 141-152.

Steinfield, C.W. & J. Fulk (1990), The theory imperative. In: J. Fulk & C.W. Steinfield (eds.) (1990), pp. 13-25.

Stolzenbach, A., Engel, P.G.H & C. Leeuwis (1993), Eindrapport tussentijdse evaluatie van de TAURUS PC-praktijkproef. Department of Communication and Innovation Studies, WAU. Wageningen.

Stryker, S. & A. Statham (1985), Symbolic interaction and role theory. In: G. Lindzey & E. Aronson (eds.) (1985), *Handbook of social psychology* (3rd edition, volume 1). pp. 311-378. Random House. New York.

Subnel, B. (1990), Informatiemodel en systeembouw: Mogelijkheden en beperkingen bij integratie van het informatiemodel in bestaande managementsystemen. In: *Agro Informatica*, Jaargang 3, Nr. 4, pp. 5-9.

Swaan Arons, H. de & P. van Lith (1984), *Expert systemen*. Academic Service. The Hague.

Tabachnick, B.G & L.S. Fidell (1989), *Using multivariate statistics, second edition*. Harper & Row. New York.

Taylor, F.W. (1947), *Scientific Management*. Harper & Row. New York.

Te Molder, H.F.M. (forthcoming), Variation in communication planners' talk: The construction of a public campaign message. (Submitted article).

Thierauf, R.J. (1982), *Decision Support Systems for effective planning and control*. Prentice-Hall. Englewood Cliffs.

Thomas, A.R. & M. Lockett (1979), Marxism and systems research: Values in practical action. In: R.F. Ericson (ed.) (1979), *Improving the human condition: Quality and stability in social systems*. Proceedings of the silver anniversary international meeting of the Society for General Systems Research, August 20-24, 1979. London. pp. 284-293. SGSR. London.

Thrift, N. (1982), On the determination of social action in space and time. In: *Society and Space*, Vol. 1, Nr. 1, pp. 23-57.

Tillmann, H.J., H. Albrecht, M.A. Salas, M. Dhamotharan & E. Gottschalk (1991), *Proceedings of the international workshop: Agricultural knowledge systems and the role of extension*, May 21-24, 1991. Höhenheim. Institut für Agrarsoziologie, landwirtschafliche Beratung und angewandte Psychologie. Höhenheim.

Trevino, L.K., L. Daft & R.H. Lengel (1990), Understanding managers' media choices: A symbolic interactionist perspective. In: J. Fulk & C.W. Steinfield (eds.) (1990), pp. 71-94.

Tuinbouwstudieclub Westland-Zuid, Projekt bedrijfsvergelijking glasgroenteteelt. Internal document d.d. 7-11-1988. Tuinbouwstudieclub Westland-Zuid. 's-Gravenzande.

Turing, A.M. (1950), Computing machinery and intelligence: Can machines think? In: *Mind*, Vol. 59. No. 236, pp. 433-460.

Turner, W.S., R.P. Langerhorst, G.F. Hice, H.B. Eilers & A.A. Uijttenbroek (1988), *SDM, System Development Methodology*. Pandata. Rijswijk.

Uhlig, R.P., D.J. Farber & J.H. Blair (1979), *The office of the future: Communication and computers*. Elsevier North-Holland. Amsterdam.

Ulrich, W. (1983), *Critical heuristics of social planning: A new approach to practical philosophy*. Haupt. Berne.

Ulrich, W. (1988), Systems thinking, systems practice, and practical philosophy: A program of research. In: *Systems Practice*, Vol. 1, No. 2, pp. 137-163.

Van Aaken, R., M. Bemelmans & J. Kemerink (1990), Gewasbescherming in komkommer. Buro Projectonderwijs, WAU. Wageningen.

Van Ammers, E.W., J.A. den Dulk & M. R. Kramer (1991), *Verkenning van de informatica: Een leerboek voor niet-informatici*. Kluwer Bedrijfswetenschappen. Deventer.

Van Beek, P.G.H. (1991), The Queensland dairy AKIS: A systems approach to the management of research and extension. In: D. Kuiper & N.G. Röling (eds.) (1991), pp. 30-44.

Van Cuilenburg, J.J. (1983), *Overheidsvoorlichting in overvloed: Over voorlichtingsonderzoek in het informatietijdperk*. Vrije Universiteit. Amsterdam.

Van den Ban A.W. & H.S. Hawkins (1988), *Agricultural Extension*. Longman Scientific & Technical. Burnt Mill.

Van den Broek, N.J. (1992), Agrarisch telematica Centrum: Tussen INSP en ATC leidt de weg naar ... In: *Agro Informatica*, Jaargang 5, Nr. 1, pp. 21.

Van der Ley, H.A. & M.D.C. Proost (1992), Gewasbescherming met een toekomst: De visie van agrarische ondernemers. Een doelgroepverkennend onderzoek ten behoeve van voorlichting. Department of Extension Science, WAU. Wageningen.

Van der Ploeg, J.D. (1987), *De verwetenschappelijking van de landbouwbeoefening*. Wageningen Studies in Sociology Nr. 21. WAU. Wageningen.

Van der Ploeg, J.D. (1990), *Labor, markets, and agricultural production*. Westview Press. Boulder.

Van der Ploeg, J.D. (1990b), The challenge of heterogeneity: Notes on science, capital and agriculture. Paper presented at the 14th European Congress of Rural Sociology, July 16-20, 1990. Giessen.

Van der Ploeg, J.D. (1991), *Landbouw als mensenwerk: Arbeid en technologie in de agrarische ontwikkeling*. Coutinho. Muiderberg.

Van der Ploeg, J.D. & D. Roep (1990), *Bedrijfsstijlen in de zuidhollandse veenweidegebieden: Nieuwe perspektieven voor beleid en belangenbehartiging*. WAU & LTB-Haarlem. Wageningen.

Van der Werff, B.M. (1992), Methoden van kennisacquisitie. In: R.J. Jorna & J.L. Simons (eds.) (1992), pp. 125-153.

Van de Vall, M. & C. Bolas (1982), Using social policy research for reducing social problems: An empirical analysis of structure and functions. In: *The Journal of Applied Behavioural Science*, Vol. 18, No. 1, pp. 49-67.

Van Dijk, G. (1988), Inleiding. In: J. Frouws & J.D. van der Ploeg (1988), pp. ix-xvii.

Van Dijk, T., P. Engel & C. Leeuwis (1991), Evaluatie AGROCOM proefproject. NCB. Tilburg.

Van Dusseldorp, D. (1990), Planned development via projects: Its necessity, limitations and possible improvements. In: *Sociologia Ruralis*, Vol. XXX, No. 3/4, pp. 336-352.

Van Gils, L.A.F.M. (1988), Keuze en ontwikkeling van voorlichtings-ondersteunende systemen. In: *Bedrijfsontwikkeling*, Jaargang 19, Nr. 6/7, pp. 180-183.

Van Groenendaal, W.J.H. (1989), Towards a workable definition of decision support systems. In: *Journal of Applied Systems Analysis*, Vol. 16, pp. 99-112.

Van Himste, R.F.I. & P.C. de Jong (1990), BETA & CERA: De user-interface. In: *Agro Informatica*, Jaargang 3, Nr. 3, pp. 8-11.

Van Houten, H.J. (1989), *Sociale experimenten met informatie-technologie*. Delphiconsult. Amsterdam.

Van Raay, W.F. (1983), Affectieve en cognitieve reacties op reclame en voorlichting. In: *Massacommunicatie*, Jaargang 17, Nr. 3, pp. 262-270.

Van Rijn, F. (1989), Consumenten-telematica: Kansen op succes? In: H. Bouwman & N. Jankowski (eds.) (1989), pp. 98-107.

Van Tilburg, P. & A. Nigten (1987), Effecten van automatisering voor de kwaliteit van arbeid, de arbeidsomstandigheden en de arbeidsvoorwaarden van werknemers in de glastuinbouw. Wetenschapswinkel report Nr. 17. Wetenschapswinkel, WAU. Wageningen.

Van Twist, M.J.W. & L. Schaap (1991), Introduction to autopoiesis theory and autopoietic steering. In: R.J. in't Veld, L. Schaap, C.J.A.M. Termeer & M.J.W. van Twist (eds.) (1991), *Autopoiesis and configuration theory: New approaches to societal steering*. pp. 31-44. Kluwer Academic Publishers. Dordrecht.

Van Velsen J. (1967), The extended-case method and situational analysis. In: A.L. Epstein (ed.) (1967), *The craft of social anthropology*. pp. 129-149. Tavistock Publications - Social Science Paperbacks. London.

Van Woerkum, C.M.J. (1979), *Sociologen over communicatie: Het begrip en verschijnsel communicatie in de sociologie*. Mededelingen Landbouwhogeschool Wageningen 79-11. WAU. Wageningen.

Van Woerkum, C.M.J. (1982), *Voorlichtingskunde en massacommunicatie: Het werkplan van de massamediale voorlichting*. Ph.D. thesis. Department of Extension Science, WAU. Wageningen.

Van Woerkum, C.M.J. (1987a), *Massamediale voorlichting: Een werkplan.* Boom. Meppel/Amsterdam.

Van Woerkum, C.M.J. (1987b), Voorlichtingskunde: Diaspora of driestromenland? In: *Massacommunicatie*, Jaargang 15, Nr. 4, pp. 331-343.

Van Woerkum, C.M.J. (1990a), Het besturen van kennissystemen: Waar zit het stuur? In: *Massacommunicatie*, Jaargang 18, Nr. 2, pp. 99-116.

Van Woerkum, C.M.J. (1990b), Het instrumentele nut van voorlichting in beleidsprocessen. In: *Massacommunicatie*, Jaargang 18, Nr 4, pp. 263-278.

Van Woerkum, C.M.J. (1990c), Mediale voorlichting. In: B. Van Gent & J. Katus (Eds.), *Voorlichting, theorieën, werkwijzen en methoden.* Bohn, Stafleu & Van Loghum. Houten.

Van Woerkum, C.M.J. (1990d), Een nieuwe benadering van ontvanger-onderzoek. In: K. Renckstorf & C.M.J. Van Woerkum (eds.) (1990), p.45-54.

Van Woerkum, C.M.J. & P. van Meegeren (1990), Environmental problems and the use of information: The importance of the policy context. In: *Knowledge in Society: The international journal of knowledge transfer*, Vol. 3, No. 3 (Fall 1990), pp. 44-49.

Van Woerkum, C.M.J. (1991), De emotionele benadering in de voorlichting. In: *Massacommunicatie*, Jaargang 19, Nr. 4, pp. 265-277.

Verheijen, G.M.A. & B.C.M. Eppenhof (1989), Van informatiemodel naar informatiesysteem. In: *Agro-informaticareeks*, Nr. 3, pp. 91-97. VIAS. Wageningen

Verstegen, J.A.A.M., A.A. Dijkhuizen, R.B.M. Huirne & J.A. Renkema (1993), Determining the profitability of management information systems: Methods and empirical results. In: H. Hogeveen (ed.) (1993), *Proceedings of the symposium on herd health decision support*, June 15-16, 1993. Utrecht. pp. 89-107.

Vickers, G. (1983), *Human systems are different.* Harper & Row. London.

Vogelzang, T. (1989), Prettig geregeld: Bedrijfsovername-regelingen in de land- en tuinbouw. Wetenschapswinkel report Nr. 37. Wetenschapswinkel, WAU. Wageningen.

Volker, J.P. (1983), De witte plekken in de voorlichtingskunde: Enige aspecten die nadere studie behoeven. In: K.J. Blokker et al. (1983), *In de Ban van de voorlichtingskunde.* pp. 54-67. Department of Extension Science, WAU. Wageningen.

Von der Lühe, N. (1991), Transfer of technology or barter trade? The rural extension service in the Atlantique Privince of Bénin as a market for negotiating resources. In: *Quarterly Journal of International Agriculture*, Vol. 30, No. 3, pp. 248-263.

Von Neumann, J. & Morgenstern, D. (1953), *Theory of games and economic behaviour.* Princeton University press. Princeton.

Von Thünen, J.H. (1930), *Der Isolierte Staat in Beziehung auf Landwirtschaft und Nationalökonomie.* Fischer. Jena.

Vonk, R. (1990), *Prototyping: The effective use of CASE technology.* Prentice-Hall. London.

VOS-WELKE (1987), Complete inventarislijst gewenste en bestaande VOSSEN per 11-11-87 (internal report/appendix of projectgroup VOS-WELKE).

Wagemans, M.C.H. (1987), *Voor de verandering: Een op ervaringen gebaseerde studie naar de spanning tussen de theorie en praktijk van het besturen.* Heythuysen.

Wallerstein, I.M. (1974), *The modern world-system: Capitalist agriculture and the origins of the European world-economy in the sixteenth century.* Academic Press. New York/London

Walsham, G. & Chun-Kwong Han (1991), Structuration theory and information systems research. In: *Journal of Applied Systems Analysis*, Vol. 17, pp. 77-85.

Wapenaar, H, N.G. Röling, & A.W. van den Ban (1989), *Basisboek voorlichtingskunde.* Boom. Meppel.

Watson, T. (1986), *Management, organisation and employment strategy.* Routledge & Kegan Paul. Boston and Henley.

Warren, D.M. (1991), The role of indiginous knowledge in facilitating a participatory approach to agricultural extension. In: H.J. Tillmann et al. (1991), pp. 161-177.

Weber, M. (1947), *The theory of social and economic organization.* The Free Press. New York.

Weber, M. (1949), *The methodology of the social sciences.* The Free Press. Glencoe, Illinois, USA.

Weber, M. (1968), *Economy and society: An outline of interpretative sociology.* Bedminster Press. New York.

Weick, K.E. (1979), *The social psychology of organizing.* Addison-Wesley. Reading USA.

Weiss, J.A. (1980), Book Review. In: *Knowledge: Creation, Diffusion, Utilization*, Vol. 2. No. 1, pp. 143-147.

Wetenschapswinkel (1988), Bemiddelingshandleiding. Wetenschapswinkel, WAU. Wageningen.

Whatmore, S.J., R.J.C. Munton, J.K Little & T.K. Marsden (1987a), Towards a typology of farm business in contemporary British agriculture. In: *Sociologia Ruralis*, Vol. XXVII, No. 1, pp. 21-37.

Whatmore, S.J., R.J.C. Munton, T.K. Marsden & J.K Little (1987b), Interpreting a relational typology of farm business in Southern England. In: *Sociologia Ruralis*, Vol. XXVII, No. 2/3, pp. 103-122.

White, T. (1990), Cognitieve Ergonomie: Een verhandeling omtrent een nieuwe vakgebied. In: *Agro-informaticareeks*, Nr. 4, pp. 189-195. VIAS. Wageningen

Wieling, H., A.H. Koops, L.E.M. Rompelberg & S. de Jong (1977), *Normen voor de voedervoorziening*. Proefstation voor de Rundveehouderij rapport Nr. 57. PR. Lelystad.

Wieling, H. (1991), Voorwoord. In: Roep, Van der Ploeg & Leeuwis (1991), pp. v.

Willemse, H. & G. Lindijer (1988), *Software ergonomie*. Academic Service. Schoonhoven.

Winch, P. (1971), *The idea of social science and its relation to philosophy*. Routledge & Kegan Paul. London.

Winner, L. (1985), Do artefacts have politics? In: D. MacKenzie & J. Wajcman (eds.) (1985), *The social shaping of technology: How the refrigerator got its hum*. pp. 26-38. Open University Press. Milton Keynes.

Winograd, T & C.F. Flores (1986), *Understanding computers and cognition: A new foundation for design*. Ablex Publishing Corporation. Norwood.

Wittgenstein, L. (1969), *The blue and brown books: Preliminary studies for the 'Philosophical Investigations'*. Basil Blackwell. Oxford.

Woodward, J. (1980), *Industrial organizations: Theory and practice*. Oxford University Press. Oxford.

Zaag, P. van der (1992), *Chicanery at the canal: Changing practice in irrigation management in Western Mexico*. CEDLA Latin America studies Nr. 65. CEDLA. Amsterdam.

Ziggers, G.W. (1991), Een tuinder: 'Een informatiesysteem, wat kan ik er mee?'. In: *Agro Informatica*, Jaargang 4, Nr. 4, pp. 10-13.

Zmud, R.W. (1990), Opportunities for strategic information manipulation through new information technology. In: J. Fulk & C.W. Steinfield (eds.) (1990), pp. 95-116.

Zwart, C.J. (1983), *Gericht veranderen van organisaties: Theorie en praktijk van de begeleiding*. Lemniscaat. Rotterdam.

Summary

Introductory chapters
In this book two lines of argumentation are developed in relation to what agro-informaticians often describe as 'the limited adoption of Management Supporting Systems in primary agricultural production'. Although -conceptually speaking- the distinction is somewhat problematic, I will speak of a 'theoretical' and a 'practical' line. Figure 1.1 in chapter 1 shows how these lines of argumentation are interwoven throughout the book.

Chapter 1 is a general introduction to the nature and scope of this book, and provides also some guidance to readers from different audiences. Moreover, and anticipating my later theoretical argument, it makes clear that I distance myself from both realist positions at the ontological level, and from positivism at the epistemological level. Instead, I adopt a constructivist stance, which posits that our understanding of the world is inherently socially constructed. Naturally, this holds for my own understanding of the world as well. Hence, preceding more detailed accounts in relation to specific case-studies, chapter 1 also touches on some broader social dimensions of this research that clarify in the context of which 'negotiation processes' this study was shaped, and which interests, projects, feelings, etc. of the researcher were of importance.

In chapter 2, I attempt to 'set the scene' by problematizing currently proposed solutions to the limited adoption of Management Supporting Systems (from now on MSS) by farmers and horticulturists. Drawing upon recent theoretical and empirical insights, I conclude that current problem definitions and solutions rest on inadequate *unilinear models* of, on the one hand, farm development and, on the other, knowledge generation, exchange and utilization.

In my practical line of argumentation, my elaborations lead me to identify five practical contributions that extension science and rural development sociology may provide to practitioners in the field of agro-informatics. Hence, I commit myself to providing such contributions in relation to: (1) the generation of relevant classifications of farmers and horticulturists; (2) the development of criteria for the design of MSS that facilitate integration of scientific and other types of knowledge; (3) the assessment of potential contributions of extension workers to the use and development of MSS; (4) the provision of inductive methodologies for identifying relevant information needs; and (5) an appraisal of the types of user-research and user-influence that can be suitably incorporated into methods for MSS-development.

In relation to the theoretical line of argumentation, I conclude that a theoretical framework for understanding the use and development of MSS will have to meet two important criteria. First, it needs to allow us to understand interactions in which MSS play a role in the (historical) context of a complex social setting in which a *variety* social actors are *actively* engaged. Second, it should help us to conceptualize the *social* dimensions of knowledge,

information, communication and rationality. Furthermore, I propose that management supporting systems or information technologies are best conceptualized as computer-based *communication technologies* (CT).

Part I: Theoretical explorations
Chapters 3, 4, 5 and 6 constitute Part I of the book. In search of a theoretical framework that meets the above formulated criteria, various disciplines and fields of study are explored in chapters 3, 4 and 5.

In chapter 3, it is argued that the dominant conceptualizations in computer science fail to meet the two criteria. The same holds for the field of information systems research. Despite important differences, neither the first, second or third wave approaches of management and organization theory, nor hard, soft, critical or autopoietic systems thinkers, provide fully satisfactory conceptualizations. In one way or another, most approaches appear to include elements of determinism, and fail to conceptualize actors as active and historically-situated agents. Similarly, even if many approaches transcend overtly simplistic 'mechanical' conceptualizations of information, they tend to emphasize the *subjective* rather than the *social* dimensions of knowledge and information. That is, due to a focus on the individual, many approaches fail to capture the political, normative and ideological dimensions of knowledge and information. Nevertheless, critical and autopoietic systems thinkers especially, provide some inspiring theoretical concepts and ideas that must somehow be incorporated into a conceptualization of CT-use and development (these include ideas concerning validity claims and the social nature of rationality, the historical and recursive nature of structure, and the concepts of thrownness, blindness and discontinuity).

In chapter 4, I discuss several frequently used approaches in communication science and extension science. In essence, my elaborations lead me to draw similar conclusions with respect to the two criteria formulated as those arrived at in chapter 3. Even if extension scientists are increasingly aware that extension processes need to be studied in a '*multi-actor*' context, this assessment has apparently not yet resulted in the development of conceptualizations that are in line with it. That is, the social dimensions of knowledge, information, communication and rationality are insufficiently explicated, and extension scientists often remain to have a rather passive conceptualization of human action. In relation to this, I argue that although extension scientists provide an interesting framework for *describing* different types of *anticipation problems* that occur in relation to CT-use and development, the 'diagnostic value' of such descriptions is limited as long as an understanding of *why* and *how* such problems emerge is lacking. Thus, I propose that there is a need to enrich both communication science and extension science with sociological conceptualizations of human action, communication, knowledge, information and rationality. Hence, I reject claims made by authors who -on the basis of a sharp distinction between 'knowledge for action' and 'knowledge for understanding'- argue that studies aimed at generating 'knowledge for understanding' are almost inherently of little use to practitioners.

Although it appears in chapter 5 that an actor-oriented sociology of rural development provides promising conceptualizations of the social actor, human action, knowledge and ignorance, I argue that there are weaknesses as well. The approach generates a number of important analytical concepts, but it is often unclear how they are to be theoretically connected. Moreover, the conceptualization of social structure leans towards 'actor voluntarism'. Another issue is that actor-oriented sociologists have so far insufficiently reflected on their own role in the production of social change, so that in its present form the approach has little to offer practitioners.

In a search for more comprehensive frameworks, I follow suggestions made by some authors in previous chapters, and continue chapter 5 with an evaluation of the prospects of Habermas' theory of communicative action, and Giddens' theory of structuration. Even if Habermas' framework is becoming increasingly popular among extension scientists, I conclude that it fails to meet the two criteria formulated, and thus that it is unsuitable for both improving our understanding of the use and development of CT in agriculture, and -more generally- for helping extension scientists to deal with 'multi-actor' intervention contexts. In contrast, a constructivist interpretation of Giddens' theory seems to meet the criteria much better. Giddens proposes that all social interaction has a communicative dimension and that the production of meaning (and therefore the production of knowledge and information) is *inherently* connected with the operation of power and normative sanctions. Furthermore, Giddens' theory demonstrates how actors are *actively* involved in (re)producing social structure. Also, it allows me to identify mutual knowledge (as inherently connected with mutual ignorance) as the key modality of structure, and therefore as underlying the existence of structural properties and the operation of power in society. In all, I conclude that Giddens' theory offers a much more promising and/or systematic insight into the interrelations between action, structure, knowledge, communication and rationality than the other sociological approaches discussed.

In chapter 6, I attempt to clear the ground for more empirical forms of investigation. Building on the insights arrived at in the theoretical explorations, I formulate a set of interrelated preliminary theoretical propositions with respect to how the use and development of CT should be understood. Most importantly, it is proposed that CT-mediated communications must be looked at as politically and normatively laden negotiation processes, which are inherently connected with the (re)production of structural properties in society. The social 'codes' incorporated into such technologies are both constraining and enabling and can be renegotiated and creatively dealt with so that largely unintended consequences can easily emerge. Moreover, such technologies are best understood as playing a -never fully neutral- role in actors' reflexive monitoring of action, rather than in processes of 'rational decision making'.

Building upon the theoretical explorations, I present the overall 'theoretical' problem statement as:

> To what extent do anticipation problems originate from: (a) the social nature of CT-development processes, and (b) insufficient recognition of the social dimensions of knowledge, information, communication and rationality.

At the 'practical' level we must add the question of how an understanding of such social dimensions can help to improve the anticipatory nature of communication technologies. Inspired by the theoretical framework adopted, I thereby translate earlier defined envisaged practical contributions into more specific guiding questions. I also formulate additional questions aimed at gaining an understanding of the role of the social scientific researcher in processes of social change.

Following this, I introduce a variety of methodological guidelines that follow from my theoretical approach. Here, it is argued that empirical studies must focus on day-to-day social practices at social interfaces. These practices must be studied in a context-sensitive manner, whereby attention must be given to actors' diverging interpretations, projects, rationalizations, and attempts to create space for manoeuvre. Furthermore, I adopt a case-study approach.

Finally, I argue that the consequences of my (meta-)theoretical framework are mainly methodological, for it proposes that a more down to earth understanding of social life must be rooted in the experiences and life-worlds of the actors that are studied. Thus, I argue that only if the methodological guidelines indeed help to increase both our understanding of the use and development of communication technologies, *and* our capacity to make practical contributions, can we conclude that (elements of) the theoretical framework, and/or (some of) the preliminary theoretical propositions are plausible and relevant.

Part II: Empirical investigations
Chapters 7, 8, 9 and 10 constitute Part II of the book. First, I elaborate in chapter 7 on the 'structural setting' in which the case-studies presented later must be understood. I critically discuss: (a) the institutional efforts to stimulate the use and development of CT in primary agricultural production; (b) current evaluations of the present state of the art in this respect; and (c) dominant methods for the development of CT in agriculture. Furthermore, I express my theoretical reservations with respect to both the frequently made distinction between 'structured', 'semi-structured' and 'ill-structured' problems, and the classifications of different types of CT that are based on this differentiation. As an alternative, I propose a classification of CT which is based on two theoretically-inspired distinctions, namely: (a) the separation between what I call the 'external' and 'internal' CT-design, and (b) a differentiation between various types of (normatively and/or politically laden) models that are more or less implicitly incorporated. In the closing section of chapter 7, I make an attempt to theorize the broader (macro) context by drawing upon Knorr-Cetina's notion of *summary representations*. First, I identify a 'web' of interrelated summary representations (in the form of classifications) that agro-informaticians frequently draw upon. Then, I make plausible: (a) that these classifications have historical, political, normative and ideological connotations; (b) that they are drawn upon in particular social practices; and (c) that they consequently underlie a number of important structural properties of the domain of agro-informatics. Finally, I illustrate that the above-mentioned classifications are inherently connected with actively and intentionally constructed areas of ignorance, and hence, that self-referential processes occur in the domain of agro-informatics.

In chapter 8, I present a case-study on the use of CT that provides dairy farmers and extension workers with a large number of parameters and norms relating to the performance of particular farms. In this study, I operationalize diversity among farmers in terms of styles of farming. By means of both quantitative and qualitative analysis, I show that farmers belonging to different styles tend to differ with respect to: (a) the parameters and norms that they focus on; (b) the goals that they formulate vis-à-vis the norms; and (c) the types of comparisons that they make with the help of the CT. Also, it appears that there are plausible connections between the specific ways of dealing with the CT, the different knowledge networks that farmers are part of, and the specific strategic notions that underlie the different farming styles. Moreover, I elaborate briefly on the way extension workers use the CT, and on some contradictions in their evaluation of farms and farmers belonging to different styles.

In the concluding section of chapter 8, I reflect on theoretical issues and on the three practical contributions that I wanted to deliver, and which guided the selection of the case. Most importantly, I arrive at the following conclusions. First, I conclude that extension workers may facilitate farmers' learning on the basis of CT, but that in this process they bring in a *different* (rather than *different levels of*) expertise and analytical capacity. Second, I argue that increasing standardization and formalization of agricultural knowledge into more and more complex models underlying CT, poses serious risks. In relation to this, I conclude that the prospects of bringing about a much needed integration of knowledge from different epistemic communities are rather limited in the internal design of a CT, and that such integration is more realistically achieved by means of an adequate external design. Third, I assess that the type of CT under consideration can be particularly useful in providing an *agenda for discussion*, that the quality of such discussions can be especially high in farmers' study clubs, and that -in the light of diversity- the provision of normative parameters in such discussions is confusing, and therefore of limited value. Fourth, I argue that existing methods for identifying 'homogeneous' target-categories rest on inadequate theoretical models, and fail to grasp the social dimensions of making such classifications. Although the classification into styles of farming proves more insightful than current classifications, there are grounds for arguing that classifications starting from different dimensions could have increased my capacity to make practical contributions in relation to the use and development of CT. Finally, I analyze why carrying out this case-study did not contribute much to social change, and develop conditions that must be met in the next case-study in order to be more effective in this respect.

Chapter 9 provides a qualitative analysis of enterprise registration and comparison practices among cucumber growers. The diversity observed in relation to these practices, leads me to develop several classifications of cucumber growers. Further qualitative analysis shows that each practice-based classification of diversity helps to both reveal the social dimensions of enterprise registration and comparison practices, and generate concrete design-criteria that any CT aimed at supporting these practices should have to meet. In relation to these criteria, I evaluate the prospects of one postal package and two CT-based packages that were actually designed to support enterprise registration and comparison activities. I conclude that the three packages are characterized by meaningful differences, and that the relative success of the packages can indeed be plausibly explained with reference to the design-criteria formulated.

In the concluding section of chapter 9, I reflect on theoretical issues and on the four practical contributions that I wanted to deliver, and which guided the selection of the case. Most importantly, I arrive at the following conclusions. First, I conclude that the making of *several* classifications of diversity on the basis of knowledge-related practices has helped to generate a sharper insight into different rationalities, knowledge networks, communication patterns and CT-use, than appeared possible with the help of the single classification into styles of farming presented in chapter 8. Moreover, the exploration of several classifications provided more insight into how diversity is socially constructed. Second, on the basis of a comparison of the CT discussed in chapters 8 and 9, I conclude that as the complexity of a CT increases, the more both the anticipation of diversity and the integration of knowledge from different epistemic communities depend on an adequate external design. Third, it emerges that CT themselves can -in time and space- play a role in facilitating the integration of knowledge from different epistemic communities. In order to achieve this, it is important to design CT in such a way that they can serve as an agenda for discussion, and facilitate (joint) processes of learning. Moreover, the case-study illustrates that such learning processes may constitute a process of 'structural change'. Fourth, the conclusion drawn in chapter 8 with respect to the role of extension workers is reinforced. Fifth, the study indicates that information needs emerge in a continuous and often routine-like process of learning. In relation to this, information needs are not only diverse, but also socially constructed, and often subject to rapid change. Therefore, my earlier plea to use inductive rather than deductive methods for the identification of such needs is reinforced. Moreover, I argue that it is more useful to identify knowledge and information-related *practices* and *types of* information requirements rather than specific information needs. Finally, I argue that in this case-study the activities of the researcher did indeed lead to a large number and variety of practical conclusions, and an impact of these on the actual course of CT-development events. I suggest that this phenomenon can be attributed to: (a) the fact that growers and researcher enrolled each other, whereby the latter became involved in an existing local project; (b) the political commitment of the researcher; (c) the fact that the practical problem statement was formulated by the growers; (d) the research methodology adopted; and (e) the institutional arrangements under which the study took place.

In chapter 10, I try to reconstruct the development histories of two CT-based packages that were designed to support enterprise registration and comparison activities. By doing so, I hope to gain insight both into why and how anticipation problems emerge, and into how software developers, growers, social scientists and extension workers may contribute to the development of adequate CT. On the basis of the reconstructions arrived at, I draw the following conclusions. First, CT-development processes emerge as complex arenas of negotiation and enrolment, in which cooperation and conflict need to be examined in the (historical) context of diverging and changing interests, resource bases, normative convictions, theoretical beliefs, spatial characteristics, etc. That is, CT-development processes are inherently social in nature, and are likely to constitute interface situations. Within and through these processes actors attempt to create longer term outcomes or structural properties, whereby they are often confronted with unintended consequences of their own and other actors' previous actions, and compelled to adapt initial goals, change routes, create new coalitions, etc. Second, CT-development processes can at the same time be fruitfully considered as being inherently social processes of learning. Third, in relation to the prospects of soft systems methodologies for enhancing such learning processes, the case-study indicates that efforts to create a negotiated 'consensus' may have counter-productive consequences when boundaries are chosen in such a way that actors with too widely diverging goals, interests, convictions, etc., are included. This seems to hold especially during the early stages of innovation processes. Fourth, even if -in practice- there appears to be only a gradual difference between project-oriented CT-development methods and prototyping, the use of planned approaches towards CT-development may at times obstruct rather than stimulate the development of an appropriate innovation in that the procedures adopted prevent the rapid inclusion of learning experiences. Finally, I argue that, if CT-development processes are learning processes, it makes sense to *organize* them as such as well. Thus, I set out to develop a 'learning-oriented' method for CT-development which incorporates methods that originate from actor-oriented sociology, extension science and prototyping approaches. The method that I propose is not so much aimed at realizing particular predefined *goals* by means of formal planning, but rather to test the feasibility and desirability of particular *ideas*, and adapt these where necessary. To this end, the method is designed as an open-ended procedure in which interveners, social scientists and various categories of prospective beneficiaries have different learning responsibilities.

Part III: Discussion and conclusions

In the concluding chapter, the theoretical line of argumentation is rounded off with, on the one hand, a reflection of the overall 'theoretical' problem statement, and on the other, some more specific conclusions in relation to the various fields of study that were covered in Part I of the book. In essence, I conclude that it has become plausible that a lack of correspondence between, on the one hand, the various models that are (more or less implicitly) incorporated in CT-design, and on the other, the models that are actually drawn upon in the context in which such CT are supposed to be used, indeed originates from both the social nature of CT-development processes, and insufficient recognition of the social dimensions of knowledge, information, rationality and communication among those that develop CT. The practical line of argumentation is brought to an end with the formulation of recommendations for practitioners in relation to the five practical contributions that I envisaged to make by means of my study.

Eventually, I conclude that a constructivist actor-oriented 'communication paradigm' constitutes an attractive perspective for both understanding and improving CT-development interventions in agriculture and horticulture.

Samenvatting

Inleidende hoofdstukken
In dit boek worden twee lijnen van argumentatie ontwikkeld met betrekking tot wat vaak wordt omschreven als 'de beperkte adoptie van Management Ondersteunende Systemen' door boer(inn)en en tuinders. Voor het gemak spreek ik daarbij van een 'theoretische' en een 'praktische' lijn, ook al betoog ik elders in dit proefschrift dat het onderscheid tussen 'theoretische kennis' en 'praktische kennis' niet scherp te maken is. Figuur 1.1 in hoofdstuk 1 laat zien hoe de twee lijnen van argumentatie in dit boek met elkaar zijn verweven.

Hoofdstuk 1 vormt een algemene inleiding op de inhoud van dit boek, en bevat tevens een leidraad voor lezers met verschillende interesses. Vooruitlopend op de theoretische discussie neem ik alvast afstand van realistische posities op ontologisch niveau en van een positivistische epistemologie. Ik stel voor om in plaats daarvan uit te gaan van een constructivistisch perspectief en aan te nemen dat ons begrip van de wereld te allen tijde sociaal geconstrueerd is. Dit geldt natuurlijk ook voor mijn eigen begrip van de wereld. Daarom probeer ik in algemene zin duidelijk te maken tegen de achtergrond van welke 'onderhandelingsprocessen' mijn onderzoek vorm heeft gekregen en welke belangen, projecten en gevoelens van de onderzoeker daarbij een rol speelden. Ook kondig ik aan dat bij de presentatie van de afzonderlijke case-studies meer gedetailleerd op dergelijke zaken zal worden ingegaan.

In hoofdstuk 2 probeer ik het terrein van onderzoek in kaart te brengen door vraagtekens te plaatsen bij de gangbare oplossingen die door agro-informatici worden voorgesteld om de beperkte adoptie van Management Ondersteunende Systemen (voortaan MOS) te bestrijden. Op basis van recente theoretische en empirische inzichten concludeer ik dat de huidige probleemdefinities en oplossingen berusten op achterhaalde *unilineaire modellen* van enerzijds landbouwontwikkeling en anderzijds kennisontwikkeling, -uitwisseling en -gebruik.

Op basis van mijn verkenning formuleer ik als beginpunt voor de praktische lijn van argumentatie vijf praktische bijdragen die de voorlichtingskunde en de sociologie van rurale ontwikkeling wellicht kunnen leveren aan op de praktijk gerichte agro-informatici. Aldus neem ik mij voor bijdragen te leveren met betrekking tot: (1) het genereren van relevante indelingen van boer(inn)en en tuinders; (2) het ontwikkelen van ontwerpcriteria voor MOS die integratie van wetenschappelijke kennis en andere typen van kennis kunnen bevorderen; (3) het vaststellen van de bijdragen die voorlichters mogelijk kunnen leveren aan de ontwikkeling en het gebruik van MOS; (4) het verschaffen van een inductieve methode voor de identificatie van relevante informatiebehoeften; en (5) een inschatting van de vormen van gebruikersonderzoek en gebruikersinvloed die zinvol kunnen worden geïntegreerd in methoden voor MOS-ontwikkeling.

Ten aanzien van de theoretische lijn van argumentatie concludeer ik, dat een theoretisch raamwerk voor het begrijpen van MOS-gebruik en -ontwikkeling zal moeten voldoen aan twee belangrijke voorwaarden. In de eerste plaats moet het theoretisch kader ons mogelijkheden bieden om interacties waarbij MOS een rol spelen te begrijpen tegen de (historische) achtergrond van een complexe sociale situatie waarin *verschillende* sociale actoren *actief* betrokken zijn. In de tweede plaats moet het ons helpen om de *sociale* dimensies van kennis, informatie, communicatie en rationaliteit in beeld te brengen en te begrijpen. Daarnaast opper ik dat Management Ondersteunende Systemen (en 'informatie-technologieën' in het algemeen) in theoretische zin het best kunnen worden begrepen als op computers gebaseerde *communicatietechnologieën* (CT).

Deel I: Theoretische verkenningen
De hoofdstukken 3, 4, 5 en 6 vormen tezamen Deel I van het boek. In een zoektocht naar een theoretisch kader dat voldoet aan de bovengenoemde voorwaarden worden in de eerste drie hoofdstukken van Deel I verschillende disciplines en gebieden van onderzoek verkend.

In hoofdstuk 3 betoog ik dat de dominante theoretische benadering in de informatica niet voldoet aan de twee voorwaarden. Hetzelfde geldt voor benaderingen in 'information systems research' en de managementwetenschap. Hoewel er verschillende stromingen zijn in deze gebieden van onderzoek kan worden gesteld dat noch de eerste, tweede of derde golf benaderingen in de organisatie- en managementtheorie, noch de harde, zachte, kritische of autopoietische systeem benaderingen, voorzien in een volledig bevredigend theoretisch perspectief. De meeste benaderingen zijn op één of andere wijze deterministisch van aard, en helpen ons niet om individuen te begrijpen als actieve en historisch gesitueerde actoren. Ook kan worden gesteld dat, hoewel veel benaderingen een al te simplistische 'mechanische' visie op het begrip informatie overstijgen, de meeste daarvan de nadruk leggen op de *subjectieve* aspecten van kennis en informatie, terwijl de *sociale* aspecten over het hoofd worden gezien. Met andere woorden, als gevolg van een gerichtheid op het individu slaagt men er niet in de politieke, normatieve en ideologische dimensies van kennis en informatie in de theorie te verwerken. Desondanks leveren vooral auteurs in de kritische en autopoietische systeemtraditie een aantal inspirerende theoretische concepten en ideeën, waarvan het van belang is dat ze worden geïntegreerd in een uiteindelijk theoretisch kader voor het begrijpen van CT-gebruik en -ontwikkeling (bijvoorbeeld ideeën met betrekking tot claims op validiteit en het sociale karakter van rationaliteit, alsmede de historische en recursieve aard van structuur, en concepten als 'thrownness', blindheid en discontinuïteit).

Hoofdstuk 4 is gewijd aan een verkenning van enkele veel gehanteerde benaderingen in respectievelijk de communicatiewetenschap en de voorlichtingskunde. De verkenning van deze benaderingen mondt in grote lijnen uit in soortgelijke conclusies ten aanzien van de in hoofdstuk 2 geformuleerde voorwaarden als die welke in het voorgaande hoofdstuk werden getrokken. Hoewel blijkt dat voorlichtingskundigen zich in toenemende mate realiseren dat voorlichtingsprocessen bestudeerd dienen te worden in een '*multi-actor*' context, kan worden vastgesteld dat deze erkenning nog niet heeft geresulteerd in de ontwikkeling van een theoretisch kader dat hiermee in overeenstemming is. De sociale aspecten van kennis, informatie, communicatie en rationaliteit worden in de huidige benaderingen nog onvoldoende expliciet gemaakt, en men blijft het menselijk handelen beschouwen als een tamelijk passief verschijnsel. In verband hiermee betoog ik dat voorlichtingskundigen een interessant raamwerk hebben ontwikkeld voor het *beschrijven* van verschillende typen *anticipatieproblemen* die voorkomen met betrekking tot het gebruik en de ontwikkeling van communicatietechnologieën. De 'diagnostische waarde' hiervan is echter beperkt zolang geen inzicht wordt gegeven in *hoe* en *waarom* deze problemen ontstaan. Ik stel daarom voor om zowel de voorlichtingskunde als de communicatiewetenschap te verrijken met sociologische perspectieven op menselijk handelen, communicatie, kennis, informatie en rationaliteit. Daarbij bestrijd ik de standpunten van auteurs die -op basis van een scherp onderscheid tussen 'kennis om te handelen' en 'kennis om te begrijpen'- betogen, dat onderzoekingen die gericht zijn op het genereren van 'kennis om te begrijpen' haast per definitie van beperkt nut zijn voor mensen in de praktijk.

Hoewel in hoofdstuk 5 blijkt dat een actor-georiënteerde sociologische benadering van rurale ontwikkeling ons voorziet van een aantal veelbelovende invalshoeken op de sociale actor, menselijk handelen, kennis en onwetendheid, stel ik vast dat er ook tekortkomingen zijn. De benadering verschaft een veelheid aan belangrijke analytische begrippen, maar het is vaak niet duidelijk hoe deze theoretisch met elkaar moeten worden verbonden. Bovendien neigt de actor-georiënteerde visie op sociale structuur naar 'actor voluntarisme'. Daarnaast hebben actor-georiënteerde sociologen tot dusver onvoldoende gereflecteerd op hun eigen rol bij het tot stand brengen van sociale verandering, waardoor deze benadering in haar huidige vorm weinig te bieden heeft aan mensen die werken in de praktijk.

Op zoek naar een meer samenhangend theoretisch kader vervolg ik hoofdstuk 5 met een evaluatie van de mogelijkheden die geboden worden door respectievelijk Habermas' theorie van het communicatieve handelen, en Giddens' structuratie theorie. Hoewel Habermas' theoretische kader zich mag verheugen in een toenemende populariteit onder voorlichtingskundigen, kom ik tot de conclusie dat het niet voldoet aan de eerder geformuleerde voorwaarden. Daaruit volgt dat het kader weinig mogelijkheden biedt om ons inzicht in het gebruik en de ontwikkeling van communicatietechnologieën in de landbouw te vergroten. Ook helpt het -meer in algemene zin- voorlichtingskundigen niet veel verder om om te gaan met interventies die in een '*multi-actor*' situatie plaatsvinden. Een constructivistische interpretatie van Giddens' structuratie theorie komt daarentegen veel verder tegemoet aan de gestelde voorwaarden. Giddens betoogt dat alle sociale interactie een communicatieve dimensie heeft, en dat de produktie van betekenis (en daarmee de produktie van kennis en informatie) inherent verbonden is met de uitoefening van macht en normatieve sancties. Verder maakt Giddens' theorie aannemelijk, dat actoren een *actieve* rol spelen in de produktie en reproduktie van sociale structuren. Tevens kan op basis van mijn interpretatie van Giddens' theorie worden betoogd, dat de centrale modaliteit van structuur wordt gevormd door gemeenschappelijke kennis en gemeenschappelijke onwetendheid, en daarmee dat gemeenschappelijke kennis en onwetendheid ten grondslag liggen aan structurele kenmerken en machtsuitoefening in de maatschappij. Per saldo kom ik tot de conclusie dat Giddens' theoretische kader ons een meer veelbelovend en/of systematisch inzicht verschaft in de relaties tussen handelen, structuur, kennis, communicatie en rationaliteit dan de overige sociologische benaderingen die ik de revue heb laten passeren.

In hoofdstuk 6 maak ik de weg vrij voor meer empirische vormen van onderzoek. Uitgaande van de inzichten die werden opgedaan in de theoretische verkenningen formuleer ik een aantal voorlopige theoretische stellingen met betrekking tot hoe we het gebruik en de ontwikkeling van communicatietechnologieën theoretisch dienen te begrijpen. Ik stel onder andere voor dat door CT gemedieerde communicaties gezien moeten worden als politiek en normatief geladen onderhandelingsprocessen, die inherent verbonden zijn met de (re)produktie van structurele kenmerken in de maatschappij. De sociale 'codes' die zijn ingebouwd in dergelijke technologieën bieden zowel mogelijkheden als beperkingen en kunnen op creatieve wijze worden her-onderhandeld, zodat het gebruik en/of de ontwikkeling van CT gemakkelijk gevolgen kan hebben die goeddeels onbedoeld zijn. Bovendien kunnen CT beter worden begrepen als artefacten die een -nooit geheel neutrale- rol spelen in de reflexieve controle en sturing van menselijk handelen dan als technologieën die een rol spelen in 'rationele besluitvorming'.

Op basis van de theoretische verkenningen formuleer ik de volgende 'theoretische' probleemstelling:

> In welke mate vloeien anticipatie problemen voort uit: (a) het sociale karakter van CT-ontwikkelingsprocessen, en (b) onvoldoende erkenning van de sociale aspecten van kennis, informatie, communicatie en rationaliteit.

Op het 'praktische' vlak voeg ik de vraag toe hoe een begrip van dergelijke sociale dimensies kan bijdragen aan het verbeteren van de mate waarin CT anticiperen op hun gebruikers. Geïnspireerd door het theoretische kader vertaal ik in verband hiermee de in hoofdstuk 2 geformuleerde voorgenomen praktische bijdragen in meer specifieke richtinggevende vragen. Ook formuleer ik een aantal extra vragen die erop gericht zijn het inzicht in de rol van de sociaal wetenschappelijke onderzoeker in processen van sociale verandering te vergroten.

In het vervolg van hoofdstuk 6 introduceer ik een aantal methodologische richtlijnen en uitgangspunten die kunnen worden afgeleid uit de gekozen theoretische benadering. Ik betoog ondermeer dat empirisch onderzoek zich zou moeten richten op alledaagse sociale praktijken die plaatsvinden op sociale raakvlakken (social interfaces). Deze praktijken dienen op context-gevoelige wijze te worden bestudeerd, waarbij aandacht geschonken moet worden aan de verschillende interpretaties, projecten en rationalisaties van actoren, en hun pogingen om manoeuvreerruimte te creëren. Ook kies ik voor een case-study benadering.

Tenslotte beklemtoon ik dat de consequenties van mijn (meta) theoretische kader vooral *methodologisch* van aard zijn, omdat het ervan uit gaat dat een meer concreet begrip van het sociale leven geworteld moet zijn in de ervaringen en leefwerelden van de betrokken actoren. Daarom stel ik voor dat pas geconcludeerd kan worden dat (elementen uit) het theoretisch kader en/of (een aantal van) de voorlopige theoretische proposities plausibel en relevant zijn, wanneer het opvolgen van de methodologische richtlijnen: (a) resulteert in een toename van ons begrip van processen van communicatietechnologie gebruik en -ontwikkeling; en (b) het ons vermogen vergroot om een praktische bijdrage te leveren.

Deel II: Empirische onderzoekingen

De hoofdstukken 7, 8, 9 en 10 vormen Deel II van dit boek. In het eerste hoofdstuk van Deel II (hoofdstuk 7) wijd ik uit over de 'structurele achtergrond' waarbinnen de later gepresenteerde case-studies moeten worden begrepen. Het hoofdstuk begint met een kritische discussie van: (a) de institutionele pogingen het gebruik en de ontwikkeling van CT in de primaire sector te stimuleren; (b) de gangbare evaluatie van de stand van zaken hieromtrent; en (c) de methoden voor de ontwikkeling van CT die in de landbouw het meest worden toegepast. Ook uit ik mijn theoretische bedenkingen met betrekking tot het vaak gemaakte onderscheid tussen 'gestructureerde', 'semi-gestructureerde' en 'ongestructureerde' problemen, en indelingen in verschillende typen van CT die op dit onderscheid zijn gebaseerd. Bij wijze van alternatief stel ik een nieuwe typologie van CT voor die gebaseerd is op twee theoretisch geïnspireerde onderscheidingen, namelijk: (a) het onderscheid tussen wat ik het 'interne' en het 'externe' ontwerp van een CT noem; en (b) een indeling van verschillende typen van (politiek en normatief geladen) modellen die meer of minder impliciet zijn ingebouwd. In de slotparagraaf van hoofdstuk 7 doe ik een poging de bredere context theoretisch te analyseren met behulp van Knorr-Cetina's begrip 'samenvattende representaties'. Allereerst identificeer ik een netwerk van onderling gerelateerde samenvattende representaties (in de vorm van indelingen) waar agro-informatici regelmatig gebruik van maken. Vervolgens maak ik plausibel: (a) dat deze indelingen historisch, politiek, normatief en ideologisch geladen zijn; (b) dat van deze indelingen gebruik wordt gemaakt in specifieke sociale praktijken; en (c) dat als een gevolg van dit gebruik dergelijke indelingen ten grondslag liggen aan een aantal belangrijke structurele kenmerken van het domein der agro-informatica. Tenslotte illustreer ik, dat de betrokken indelingen inherent verbonden zijn met actief en intentioneel geconstrueerde gebieden van onwetendheid, en dat er aldus zelf-referentiële processen plaatsvinden in het domein der agro-informatica.

In hoofdstuk 8 wordt een case-studie gepresenteerd naar het gebruik van een CT die ten behoeve van melkveehouders en voorlichters een groot aantal kengetallen en normen genereert, met behulp waarvan bedrijfsresultaten kunnen worden geanalyseerd. In deze studie operationaliseer ik diversiteit onder melkveehouders in termen van bedrijfsstijlen. Met behulp van kwantitatieve en kwalitatieve analyses laat ik zien dat boeren met uiteenlopende bedrijfsstijlen verschillen met betrekking tot: (a) de kengetallen en normen waar zij de nadruk op leggen; (b) de doelen die zij ten opzichte van de normen formuleren; en (c) het type vergelijkingen dat zij met behulp van de CT maken. Ook wordt duidelijk dat er plausibele verbanden zijn tussen de specifieke wijze waarop wordt omgegaan met de CT, de verschillende kennisnetwerken waar boeren deel van uitmaken, en de specifieke strategische overwegingen die ten grondslag liggen aan de verschillende bedrijfsstijlen. Verder besteed ik kort aandacht aan de manier waarop voorlichters gebruik maken van de CT en aan een aantal tegenstrijdigheden in hun beoordeling van bedrijven en boeren die behoren tot verschillende stijlen.

In de slotparagraaf van hoofdstuk 8 stel ik een aantal theoretische zaken aan de orde en kom ik terug op de drie praktische bijdragen die ik met behulp van de case-studie wilde leveren. Mijn belangrijkste conclusies zijn de volgende. Ten eerste concludeer ik dat voorlichters een faciliterende bijdrage kunnen leveren aan het leren van boeren op basis van communicatietechnologieën, en dat zij hierbij een *ander(e)* (en niet zoals vaak wordt aangenomen een *ander niveau van*) expertise en analytisch vermogen inbrengen. Ten tweede betoog ik, dat de toenemende standaardisering en formalisering van agrarische kennis in steeds complexere modellen die ten grondslag liggen aan CT, een aantal serieuze risico's met zich meebrengt. In verband hiermee constateer ik, dat de zeer gewenste integratie van kennis die afkomstig is van verschillende epistemische gemeenschappen, slechts in beperkte mate tot stand te brengen is met behulp van het interne ontwerp van een CT. Een dergelijke integratie kan beter gerealiseerd worden met behulp van een weldoordacht extern ontwerp. Ten derde stel ik vast, dat het bestudeerde type CT vooral nuttig kan zijn voor het verschaffen van een *agenda voor discussie*, dat de kwaliteit van dergelijke discussies vooral hoog kan zijn in studiegroepen van boeren, en dat -in het licht van de geconstateerde diversiteit- het aanbieden van normatieve kengetallen in dergelijke discussies verwarrend is en daarom van beperkte waarde. Ten vierde betoog ik, dat de gangbare methoden voor het identificeren van 'homogene' doelgroepen berusten op inadequate theoretische modellen, en onvoldoende aandacht schenken aan het feit dat het maken van doelgroepclassificaties een sociale activiteit is. Hoewel de in dit hoofdstuk gehanteerde indeling in bedrijfsstijlen meer inzicht blijkt te verschaffen dan gangbare classificaties, zijn er ook redenen om aan te nemen dat indelingen op basis van andere dimensies wellicht meer geschikt zijn om een praktische bijdrage te leveren aan het gebruik en de ontwikkeling van CT. Tenslotte probeer ik te verklaren waarom het uitvoeren van deze case-studie weinig heeft bijgedragen aan sociale verandering, en probeer ik voorwaarden te formuleren die in een volgende case-studie vervuld moeten zijn om in dit opzicht meer effectief te zijn.

Hoofdstuk 9 bevat een kwalitatieve analyse van bedrijfsregistratie- en bedrijfsvergelijkingspraktijken onder komkommertelers. De diversiteit met betrekking tot deze praktijken brengt mij er toe een aantal indelingen te maken van komkommertelers. Verdere kwalitatieve analyses tonen aan, dat elke op praktijken gebaseerde karakterisering van diversiteit behulpzaam is bij zowel het aan het licht brengen van de sociale aspecten van bedrijfsregistratie- en bedrijfsvergelijkingspraktijken, als bij het formuleren van concrete criteria waaraan elke CT die gericht is op het ondersteunen van deze praktijken wellicht zou moeten voldoen. Op basis van deze criteria evalueer ik vervolgens de mogelijkheden van één op postverwerking gebaseerd pakket en twee communicatietechnologieën die alle drie ontworpen waren om bedrijfsregistratie en -vergelijkingsactiviteiten te ondersteunen. Ik concludeer dat de drie pakketten gekenmerkt worden door wezenlijke verschillen, en dat het relatieve succes van de pakketten op plausibele wijze verklaard kan worden met behulp van de eerder geformuleerde criteria.

In de slotparagraaf van hoofdstuk 9 stel ik wederom een aantal theoretische zaken aan de orde en kom ik terug op de vier praktische bijdragen die ik met behulp van deze case-studie wilde leveren. Mijn belangrijkste conclusies zijn de volgende. Ten eerste concludeer ik dat het maken van *verscheidene* indelingen van diversiteit op basis van aan kennis gerelateerde praktijken, meer heeft bijgedragen aan het krijgen van een scherp inzicht in verschillende rationaliteiten, kennisnetwerken, communicatiepatronen en CT-gebruik, dan mogelijk bleek met de enkelvoudige classificatie van bedrijfsstijlen die in hoofdstuk 8 werd gepresenteerd. Eveneens werd via het exploreren van verscheidene indelingen meer inzicht verschaft in hoe diversiteit sociaal wordt geconstrueerd. Ten tweede concludeer ik op basis van een vergelijking van de in hoofdstuk 8 en 9 besproken CT, dat naarmate de complexiteit van een CT toeneemt, zowel de mate waarin CT anticiperen op diversiteit, als de mate waarin integratie van kennis tot stand gebracht kan worden, meer afhankelijk is van een adequaat extern ontwerp. Ten derde blijkt dat -in tijd en ruimte- CT zelf ook een rol kunnen spelen in het tot stand brengen van integratie van kennis die afkomstig is van verschillende epistemische gemeenschappen. Om een dergelijke integratie te bereiken is het van belang om CT zodanig te ontwerpen, dat ze kunnen dienen als een agenda voor discussie, en dat ze faciliteiten bieden om (gezamenlijke) leerprocessen te ondersteunen. De case-studie illustreert voorts dat dergelijke leerprocessen een proces van 'structurele verandering' kunnen behelzen. Ten vierde bevestig ik de reeds in hoofdstuk 8 getrokken conclusie ten aanzien van de rol van voorlichters. Een vijfde conclusie luidt dat informatiebehoeften ontstaan in een continu en vaak routinematig leerproces. In verband hiermee zijn informatiebehoeften niet alleen divers, maar ook sociaal geconstrueerd, en vaak aan snelle verandering onderhevig. Dit brengt mij er toe nogmaals het belang van het gebruik van inductieve (in plaats van deductieve) methoden voor het identificeren van informatiebehoeften te onderstrepen. Bovendien stel ik dat het zinvoller is om aan kennis en informatie gerelateerde *praktijken* en *typen van* informatiebehoeften te identificeren, dan om te zoeken naar hele specifieke informatiebehoeften. Tenslotte betoog ik dat de activiteiten van de onderzoeker in deze case-studie wel hebben geleid tot een grote verscheidenheid aan praktische conclusies, alsmede een invloed hiervan op de feitelijke loop der gebeurtenissen rondom CT-ontwikkeling. Ik suggereer dat dit fenomeen kan worden toegeschreven aan: (a) het feit dat de tuinders en de onderzoeker elkaar hebben gerecruteerd in hun wederzijdse projecten, waarbij de onderzoeker betrokken werd bij een reeds bestaand lokaal project; (b) de politieke stellingname van de onderzoeker; (c) het feit dat de praktische probleemstelling werd vastgesteld door de tuinders; (d) de gebruikte methode van onderzoek; en (e) de institutionele voorwaarden waaronder het onderzoek plaats vond.

In hoofdstuk 10 probeer ik de ontwikkelingsgeschiedenissen te reconstrueren van twee communicatietechnologieën die waren ontworpen om bedrijfsregistratie en -vergelijkingsactiviteiten te ondersteunen. Dit om inzichten te verkrijgen in hoe anticipatieproblemen ontstaan, en in hoe software ontwikkelaars, tuinders, sociale wetenschappers en voorlichters kunnen bijdragen aan de ontwikkeling van adequate CT. Op basis van de reconstructies concludeer ik het volgende. Ten eerste blijkt dat CT-ontwikkelingsprocessen gezien kunnen worden als complexe arena's van onderhandeling en recrutering, waarbinnen samenwerking en strijd begrepen moeten worden tegen de (historische) achtergrond van uiteenlopende en veranderende belangen, machtsbases, normatieve overtuigingen, theoretische opvattingen, ruimtelijke kenmerken, etc. Met andere woorden, processen van CT-ontwikkeling zijn inherent sociaal van aard, en vormen veelal een raakvlak situatie (interface situation). Via hun bijdragen aan deze processen proberen actoren om op termijn bepaalde uitkomsten en structurele kenmerken te realiseren. Daarbij worden zij vaak geconfronteerd met de onbedoelde gevolgen van hun eigen en/of andermans handelen, en zijn ze vaak gedwongen om hun doelen aan te passen, andere routes te kiezen, nieuwe coalities te smeden, etc. In de tweede plaats kunnen processen van CT-ontwikkeling zinvol worden beschouwd als inherent sociale leerprocessen. Ten derde roept de case-studie twijfel op ten aanzien van de mogelijkheden om dergelijke leerprocessen met behulp van zachte systeem (soft systems) methoden te verbeteren. De studie laat zien dat pogingen om een onderhandelde 'consensus' te bereiken contraproduktief kunnen zijn wanneer de grenzen zodanig worden gekozen dat actoren met te ver uiteenlopende doelen, belangen, en overtuigingen, bij het proces worden betrokken. Dit lijkt vooral te gelden gedurende de beginstadia van innovatieprocessen. Ten vierde kan worden gesteld dat, hoewel er in de praktijk slechts een gradueel verschil bestaat tussen project-georiënteerde methoden van CT-ontwikkeling en prototyping, het gebruik van geplande procedures van CT-ontwikkeling de totstandkoming van een geschikte innovatie soms eerder belemmert dan stimuleert. Dit omdat de gebruikte procedures een snelle incorporatie van leerervaringen beletten. Tenslotte betoog ik dat, wanneer processen van CT-ontwikkeling leerprocessen zijn, het zin heeft dergelijke processen ook als zodanig te *organiseren*. In verband hiermee ontwikkel ik een 'leer-georiënteerde' methode voor CT-ontwikkeling die methoden ontleent aan de actor-georiënteerde sociologie, de voorlichtingskunde, en prototyping benaderingen van CT-ontwikkeling. De methode die ik voorstel is niet zozeer gericht op het realiseren van vastomlijnde en vooraf gedefinieerde *doelen* met behulp van formele planning, maar op het testen van de haalbaarheid en wenselijkheid van bepaalde *ideeën*, en het aanpassen hiervan indien nodig. De methode is daarom ontworpen als een open procedure, waarin interventionisten, sociale wetenschappers en een aantal categorieën van beoogde begunstigden verschillende leer-verantwoordelijkheden hebben.

Deel III: Discussie en conclusies

In het slothoofdstuk besluit ik de theoretische lijn van argumentatie met enerzijds een reflectie op de overkoepelende 'theoretische' probleemstelling, en anderzijds een aantal meer specifieke conclusies met betrekking tot de gebieden van onderzoek die in Deel I aan de orde kwamen. In essentie concludeer ik dat aannemelijk is geworden dat een gebrek aan overeenstemming tussen de verschillende modellen die (meer of minder impliciet) zijn geïncorporeerd in CT-ontwerpen, en de modellen waaraan gerefereerd wordt in de context waarin een CT zou moeten worden gebruikt, inderdaad voortkomt uit zowel de sociale aard van processen van CT-ontwikkeling, als een gebrek aan erkenning van de sociale aspecten van kennis, informatie, communicatie en rationaliteit onder CT-ontwikkelaars. De praktische lijn van argumentatie wordt besloten met de formulering van aanbevelingen voor mensen in de praktijk. De aanbevelingen hebben betrekking op de praktische bijdragen die ik beoogde te leveren met behulp van dit onderzoek.

Uiteindelijk concludeer ik dat een constructivistisch en actor-georiënteerd 'communicatie paradigma' een aantrekkelijk perspectief vormt voor zowel het begrijpen als het verbeteren van interventies op het gebied van communicatietechnologie-ontwikkeling in de land- en tuinbouw.

Curriculum Vitae

Cees Leeuwis was born in Ede the Netherlands in December 1962. In 1981, he completed the Atheneum-B at the Marnix College in Ede. Subsequently, he commenced a study in Landscape Architecture at Wageningen Agricultural University. He adjourned this study in 1983. In 1983, he worked for half a year on a large dairy farm on an Israeli Kibbutz, before returning to Wageningen Agricultural University and commencing a M.Sc. programme in Rural Sociology in 1984.

In 1986, Leeuwis spent six months in the West of Ireland in order to collect material for a M.Sc. thesis. This research focused on different development strategies among cattle and sheep farmers in this peripheral region. Farmers' strategies vis-à-vis the institutional environment were a major concern during this study, as well as a detailed analysis of different farming practices that accompanied these strategies. On return, he became a member of the executive board of the Wetenschapswinkel ('Science Shop') at Wageningen Agricultural University, and acted as an intermediator between university departments and less-endowed groups in the agricultural sector (1987 until 1989).

The major subjects during his M.Sc. study were Agrarian Sociology of Rural Development, Research Methodology and Extension Science. He completed his M.Sc. in Rural Sociology in 1988 with distinction, 'cum laude'.

Between 1988 and 1993, he was employed as a researcher in the Department of Communication and Innovation Studies (formerly the Department of Extension Science). At present, he is a member of academic staff in the same department.