



The Design of an Innovation- Enhancing Environment



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Introduction

The Netherlands traditionally has a strong agro-food sector. The post-war development of knowledge was directed towards high-productivity agriculture. While this approach was very successful, it has now become apparent that there is a drawback to this success. Specialization not only leads to economic profit, but also to environmental pressures and encroachment on public spaces. The agro-food sector is running into ecological and social barriers. There is a clear need for a more sustainable development in the sector, that gives attention to not only 'prosperity', but also to 'planet' and 'people'.

TransForum was created to address this challenge. The needed development calls for innovations and new insights. Therefore, TransForum has a double goal: to demonstrate, together with entrepreneurs that there are viable new pathways, and to prove, together with knowledge institutions, that the needed knowledge can be delivered.

We try to deliver these results in a combination of a practice program and a scientific program. The programs are meant to deal with three main obstacles in a route towards sustainable development in agriculture. First, there is a tendency to only search for new potential within your own sector (in business) or discipline (in science). Second, there is a strong bias on the function of agriculture in relation to regional development, blocking new combinations of functions. Third, in almost all explorations the value added is supposed to be in the primary production of the chain. Possibilities further in the chain are overlooked, and 'knowledge about primary production' is not seen as an asset. We try to tackle these obstacles by creating consortia of people from business, knowledge institutions, (local) authorities and societal organizations.

The scientific program is meant to address knowledge questions that arise from the practice projects. To that end a division into five sub themes is developed that reflect different aspects of the innovation process. These themes are: (1) Images of sustainability, (2) Inventions for a sustainable agriculture (3) Organization of Innovation and Transition (4) Mobilization of Sustainable Consumption and (5) Design of an Innovation-Enhancing Environment.

This publication contains a number of commissioned position papers that were helpful to focus the scientific program. However, we feel that the content of these papers deserves broader attention. We hope that after reading them, you will agree.

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The Design of an Innovation-enhancing environment

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In order to support innovation processes in the new agro system characterised by sustainable production and high added value products and services, the 'old' innovation system, very successful in supporting the mass production based agro system, has to go through a structural transition. The central goal of this theme is to produce scientific insights and science based instruments that contribute to the design and implementation of an innovation system producing knowledge needed in the new agro system.

The central questions of this program focus on (i) the characteristics of such an innovation system, (ii) barriers and incentives that hinder/facilitate the necessary transition, and, (iii) strategies that support the transition towards the 'new' innovation system.

Two position papers address (partially) the issues put central in this theme of the scientific program.

Equivocations on the post privatisation dynamics in agricultural innovation systems has more a design character and takes the view that in order to understand the 'new' we need to start with placing it in the context of the 'old'. The focus in this paper is on 'new knowledge arrangements'. Based on a state of the art analysis, first experiences with new knowledge arrangements are analysed. Promising developments and barriers are identified and a number of research themes are proposed. This research could contribute to all three research questions. Knowledge management in international networks focuses on knowledge and networks. Starting point of this paper is the dual observation that although the creation, diffusion and utilization of knowledge in networks is of utmost importance for the functioning of innovation systems and the performance of firms operating in these systems, at the same time it has to be concluded that research into this theme is scarce. Taking innovative international networks in the agro sector as the main object of the analysis, the paper proposes research to deepen insights into the functioning of these networks. This research could contribute to answering question 2.

Equivocations on the post privatization dynamics in agricultural innovation systems

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Executive summary

This position paper discusses insights about the success and failure of 'new knowledge arrangements', and gives suggestions for a research program that might be carried out under the banner of TransForum. First, it discusses the influences that led to the demise of the once famous publicly funded Education, Extension and Research triptych, which preceded the emergence of and interest in 'new knowledge arrangements'. Key influences here include the breakdown of consensus about desirable directions for agricultural development, and the decreasing viability of standardized mass production in the Netherlands in view of wider international market developments. The paper proceeds to outline two major conceptual bodies that have been used to underpin 'new knowledge arrangements': the economically oriented discourse about privatization, and an innovation theoretical body of thought. The first discourse emphasizes the need for new funding arrangements as well as new roles for the state in order to prevent market failure in the knowledge realm. In the second discourse the idea of 'innovation' is reconceptualized, which leads to the identification of new roles and services for both scientists and communication specialists in contexts where innovation is to be supported. It is concluded from this that different spheres of 'new knowledge arrangements' can be distinguished, i.e. new services, new funding arrangements, new forms of market supervision, and new institutional conditions.

After this conceptual introduction, the position paper sets out to make empirical observations about the functioning of the current innovation system that is dominated by 'new knowledge arrangements' (and/or experiments with these) of various kinds. A range of 'positive' and 'problematic' aspects are discussed in view of the ambition to support innovation, whereby

the 'problematic' aspects tend to dominate the landscape. It is argued essentially that the 'new knowledge arrangements' deriving from the privatization discourse tend to be counter-productive in fostering new arrangements needed from the viewpoint of innovation theory. It appears that commercialization of service delivery can easily lead to interaction patterns that hinder the flexible cooperation, learning ability, pro-activeness and creativity that is necessary in order to enhance innovation.

In order to support the further development of -more conducive- knowledge arrangements in the (agro, ecological or rural) innovation system, 9 themes for research are proposed:

- (1) Theoretical research on the role of new arrangements in innovation systems: This research line serves to give the idea of 'new knowledge arrangements' a better grounding in innovation theory. It should be clarified e.g. how such arrangements are linked to innovation systems, systemic failures, systemic instruments, competencies as well as to different kinds, phases and pathways of innovation.
- (2) Historical documentation and analysis of the agricultural innovation system: A thorough historical study of the functioning of the agricultural innovation system in different periods, as well as comparison with other sectoral innovation systems, is likely to produce insights that are relevant in view of the current challenges that the knowledge infrastructure is facing.
- (3) Systematic inventory and comparison of already existing new arrangements: A clear and systematic overview of new arrangements since the 1990s is remarkably absent. An overview of newly emerging arrangements and their characteristics could contribute to transparency of the knowledge infrastructure. Comparison with other European countries is of interest as well.
- (4) Ex-post assessment of the contribution of new arrangements to innovation: In addition to making a descriptive overview of new arrangements, it would be important to systematize the lessons learned regarding these new arrangements. This should result in methodological and praxeological guidelines.
- (5) The social shaping of everyday interaction in new knowledge arrangements: In addition to drawing lessons, we need to develop a better theoretical understanding of why specific productive or non-productive patterns of interaction emerge within knowledge arrangements. Such understanding of 'structuring principles' is especially important to improving institutional conditions in the innovation system.

(6) Methodology development for reflexive innovation process monitoring: Dominant modes of monitoring and evaluation have many limitations for assessing progress in innovation oriented programs. However, a feasible monitoring and evaluation approach that is suitable for both (a) assessing the contribution of different knowledge arrangements to innovation, and (b) enhancing the learning capacity within specific innovation trajectories, is lacking. Developing and testing such an approach would be beneficial to TransForum in various ways.

- (7) Coping strategies and self-organization in the knowledge infrastructure:
In the face of existing challenges in the knowledge infrastructure, coping strategies of active agents are likely to result in informal and largely hidden 'new knowledge arrangements'. Increased insight in informal solutions and forms of self-organization may provide crucial information for improving the functioning of the knowledge infrastructure.
- (8) Development and evaluation of methodological approaches and pathways for scaling out, scaling up and multi-level learning: The realization that innovations consist of 'hardware', 'orgware' and 'software' at multiple societal aggregation levels requires reconsideration of conventional approaches to enhancing 'diffusion'. The development, evaluation and comparison of various methodological strategies or tools for discovery learning within and between levels and networks would be an interesting area of study, which could be implemented in an action research mode in TransForum's Scientific Projects.
- (9) Assessing the contribution of TransForum to innovation and institutional change: TransForum itself qualifies as a 'new knowledge arrangement' with a mandate to contribute to innovation and transition, with specific attention to realizing a transition in the knowledge infrastructure from mode 1 to mode 2. In order to succeed, TransForum's efforts to renew the knowledge infrastructure need be monitored and evaluated in a reflexive manner.

1. Introduction

This paper was solicited by TransForum under the title 'New knowledge arrangements for enhancing innovative capacity and sustainability of medium and small business'. A key ambition of this BSIK program is to contribute to the renewal of the agricultural knowledge infrastructure, so that it becomes more effective in supporting innovation towards sustainable agriculture and multi-functional land-use. 'New knowledge arrangements' (i.e. new methods and forms of interaction between users and producers of knowledge, as well as new institutional arrangements supporting these) are deemed necessary to move from a technology and supply driven knowledge infrastructure to a demand driven and trans-disciplinary innovation system. The purpose of this position paper is to sketch a state-of-affairs with regard to insights that are available regarding the success and failure of 'new knowledge arrangements', and to give suggestions for a research program that might be carried out under the banner of TransForum. We take the view that in order to understand the 'new' we need to start with placing it in the context of the 'old', which is why the paper starts with some historical background on the 'Education, Extension and Research (EER) tryptich' that dominated the Dutch agricultural knowledge infrastructure for decades. It then continues to outline two academic (and policy) discourses that have been influential in the emergence of 'new knowledge arrangements'. On the basis of this we present a new typology of knowledge arrangements that can be considered as 'new', and signal that a great diversity of arrangements is operative in actual practice. We then take a birds-eye view on the functioning of the current knowledge infrastructure, and sketch several positive developments, as well as a range of more problematic issues. Building on gaps in understanding identified, we conclude with the formulation of a number of research themes.

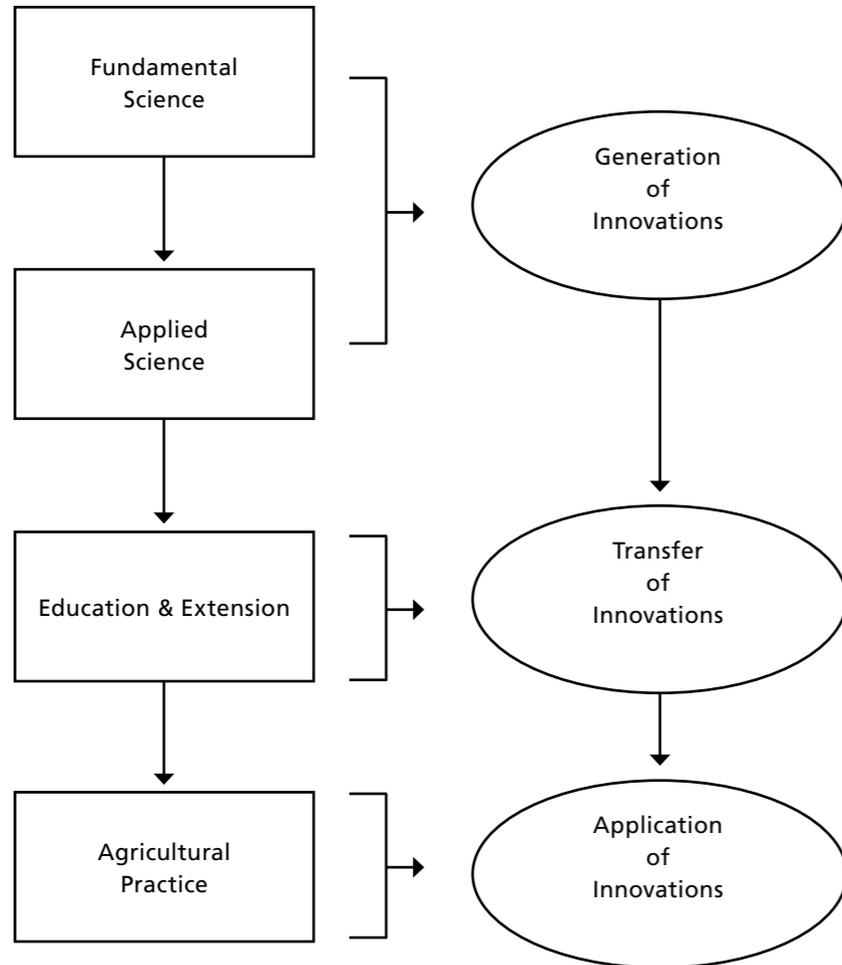
2. History: the rise and fall of the publicly financed EER system

At present we witness a lot of attention for 'new knowledge arrangements' for stimulating innovation in the agricultural sector. In order to understand the opportunities, challenges, potential and limitations of such 'new arrangements' it is important to position them briefly in the historical context of 'old knowledge arrangements'. These old arrangements are often referred to as the publicly financed 'Education, Extension and Research (EER) tryptich' (OVO drieluik). Government investment in agricultural research, extension and education dates back to the agricultural crises in the late 19th and early 20th centuries, when government realized that the farming sector (consisting of many small and impoverished farmers) was unable to invest much in the further development and innovation of the sector (Koning, 1982). At the same time, it was realized that investments in the agricultural knowledge infrastructure were economically profitable in that they led to quick expansion of the sector, resulting in increased national income and export earnings. Public investments in agricultural research, extension and education started in the late 19th century, were intensified after World War II, and culminated in the agricultural modernization project that was inspired by Sicco Mansholt (Bieleman, 2000). It resulted in the Netherlands becoming the second largest exporter of agricultural products in the world around 1980. The knowledge infrastructure, which supported and drove the rapid specialization, scale enlargement and intensification in the sector consisted of a complex web of interlinked institutions. In the sphere of research, this included a large agricultural university, many specialized institutes for strategic research, numerous experimental stations for applied research and locally operating experimental/demonstration farms. In the sphere of extension there existed a large army of technical and socio-economic field workers who were supported by (disciplinary and sector) specialists with the task of translating and integrating insights from research into relevant information for extension. A differentiated network of lower, intermediate and higher agricultural schools completed the EER tryptich. The research and extension component was administered jointly by the government and farmers' organizations in a corporate institution (Landbouwschap). Half of the funding of, for instance, the applied research and experimental stations came from the government, and the other half was paid by the farming sector mostly in the form of product levies.

The philosophy behind the EER triptych clearly resembled the 'the linear model of innovation' (Kline & Rosenberg, 1986) which tends to draw a straight and one-directional line between science and practice: Science finds, Industry applies and Man conforms (as it was expressed during the World Expo in Chicago in 1933; Smits, 2002) It was basically assumed that innovations

originate from scientists, are transferred by extension workers and other intermediaries, and are applied by agricultural practitioners (see Figure 1).

Figure 1: The linear model of innovation



Supported by theories about the adoption and diffusion of innovations (Rogers, 1962, 1995; Van den Ban & Hawkins, 1988, Havelock, 1986) a further assumption underlying the then 'received view' was that there existed basically one agricultural development path which all farmers who wanted to continue farming should and would follow sooner or later (see Van der Ploeg, 1990).

The Dutch EER triptych became internationally known for its success in contributing to attaining the then prevailing policy objectives, which centered on increasing production and productivity. In international literature (FAO & World Bank, 2000) systems like the EER triptych are described as Agricultural Knowledge and Information Systems (AKIS): "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 synergistically (?) to support decision making, problem solving and innovation in a given country's agriculture or domain thereof" (Röling, 1989:1).

The Dutch AKIS was regarded as a successful example of such a system. In retrospect, the relative success of the Dutch AKIS until the 1980s can be attributed to a number of key factors.

- (1) The AKIS was embedded in and supported by a range of other supportive policies and institutions (e.g. price policies, trade policies, credit facilities, land consolidation, etc.) which created conducive conditions for investing in farm development.
- (2) Policy makers, politicians, knowledge workers and leading farmer organisations were largely in agreement about the desirable development path of agriculture. In other words, there existed a dominant consensus and shared vision that guided activities in the AKIS, and which greatly enhanced synergy (Röling, 1989; Van der Ploeg, 1987, 1999). Early protests about the pursued development direction (e.g. relating to the enforced exodus of small farmers and negative environmental consequences) were effectively side lined and ignored.
- (3) Although the philosophy of the AKIS was linear, there existed formal and informal feedback loops through which farmer's exerted influence on the research and extension agenda. In the corporate Landbouwschap and its committees, farmers were involved in priority setting, and at the local level too (e.g. at experimental/demonstration farms) intensive interaction between selected farmers, extensionists and applied researchers existed and contributed to tailoring research and extension efforts to the needs and initiatives of those who wished to embark on the modernisation project (Röling, 1989; Vijverberg, 1997).
- (4) Even if the AKIS consisted of many different institutions with considerable autonomy, the large majority of research and extension staff came in one way or another under the com-

petency of the Ministry of Agriculture. In addition to being guided by a shared vision, this collective organizational affiliation facilitated a great deal of formal and informal exchange, and ensured relatively low obstacles to co-operation. Knowledge workers along the science-practice continuum (Röling, 1988) were expected and assumed to cooperate (rather than compete) with each other.

- (5) Because the agricultural policy was directed to supporting mass production and standardisation, the knowledge institutes could serve an increasingly homogeneous demand of farmers which made it easier to tune the supply and demand of knowledge (Smits 2002).
- (6) Last but not least, the knowledge products delivered by the AKIS could be accessed by farmers and other agricultural sector 'free of charge', and were in fact actively distributed and promoted by the extension service in particular.

The breakdown of the publicly funded AKIS

From the early 1980s onwards the dominant view on agricultural development became more and more contested. Societal pressure groups and scientists criticized modern agriculture for its detrimental effects on the natural environment and the world ecology at large. Soil and water pollution, excessive use of chemicals, waste of water, decreasing ground water tables, destruction of natural habitats for wildlife, and limited animal welfare were just a few of the concerns raised by environmentalists, ecologists, nature conservationists, consumers and the public at large. Thus, new societal parties, problem definitions and objectives entered the agricultural policy arena, while the old policy objective (increasing agricultural production) had become less relevant in view of substantial overproduction in key sectors. In this context, public and political support for investing in and/or subsidizing the agricultural sector diminished. Even more so since agricultural entrepreneurs could no longer be characterized as 'poor' and became less important from an electoral point of view (their share in total population decreased steeply over the last 40 years), while the sector as a whole became less significant relative to other economic sectors. As a result of this 'crisis' we nowadays witness many different views regarding the possible and desirable scenarios for agricultural development, including e.g. agricultural exit scenarios (Vereijken, 2003), further scale enlargement and intensification by means of precision agriculture, multifunctional land-use and/or biological agriculture.

In addition to the ecological and environmental concerns, it became increasingly clear that, in the long term, Dutch agriculture would not be able to compete internationally with mass production and consequently on price. Other regions in and outside Europe have important comparative advantages in terms of the potential for scale enlargement and the costs of land, labour and energy. Also from an economic perspective, therefore, new directions -such as durable production of specialties- had to be found (Smits, 2002; Van der Ploeg & Ettema, 1990).

This implied that the agricultural knowledge infrastructure could no longer suffice to produce homogeneous technologies and messages in support of standardization, but would have to anticipate customers with very different demands and wishes.

Against these backgrounds, the dominant policy view became that the AKIS could not remain a purely agricultural affair, and that it needed to open up to new societal players (e.g. consumers, nature conservationists, environmentalists, etc.) in order to be able to deal with the new societal concerns, options and priorities. The agricultural sector (including the AKIS) was seen to respond rather slowly to the redefined public interest, and the existing AKIS was increasingly looked upon as an obstacle (i.e. as part of a defensive agricultural lobby) rather than as a stimulant to desirable change (Verkaik & Dijkveld Stol, 1989). In short, the dominant consensus between government, farmer's organizations, knowledge workers and politicians broke down (Tacken, 1998; Wielinga, 2000).

As a consequence, the traditional Iron Triangle of the Ministry, parliamentary agricultural specialists and farmers' organization gave way to a variety of new policy arrangements (Wisselhof, 2000). In the context of wider ambitions to reduce government spending, a range of neo-liberal arrangements arose since the mid 1980s, focusing on 'market-conform' policy measures to stimulate reform. Since the mid 1990s, that saw crises especially in the area of livestock systems, also civic arrangements emerged, in which farmers, other market parties and NGOs co-operated towards reform.

These two kinds of new policy arrangements had as their counterparts new arrangements in the AKIS. First, governmental response to the problems in the AKIS was dominated by embarking on a trajectory of legal privatization of research and extension institutions, accompanied with the introduction of radically new financing mechanisms and procedures. This trajectory started in 1990 with the privatization of the extension service. Soon afterwards applied research institutes (later followed by strategic research) were set at a distance and became independent. In the process that followed, many institutes for strategic and applied research merged and became part of a joint venture with Wageningen University, while many regional experimental stations and farms have been closed down. The public extension service was transformed into a considerably downsized private service, which competes with many smaller (and some large) agro-consultancy firms. In addition, new private organizational forms as well as new public/private partnerships (see section 5) emerged. Altogether this has resulted in a significantly transformed knowledge infrastructure, as well as radically changed dynamics and interaction patterns within this institutional landscape. Among knowledge workers it is common to say that the EER tryptich is no more operational or has been dissolved, which indicates that people indeed experience a considerable shift in their mode of operating.

Before providing a sketch of the current situation in the Dutch knowledge infrastructure, we

will first discuss two bodies of thought that underpin the kind of 'new knowledge arrangements' that are in place and/or needed in the Dutch innovation support system. These underpinnings derive from two different discourses, one about privatization, and the other about (system) innovation.

3. Discourse 1: Privatization in research and extension

On the wave of the generally increased trust in market forces after the end of communism in the late 1980's and early 1990's, privatization has become an international trend in many societal sectors and arenas since the early 1980s. In the field of agricultural research and extension, privatization was put on the agenda by international institutions such as the World Bank. In most countries, the main rationale for embarking on privatization was that public extension and research organisations were seen as operating in an inefficient, bureaucratic, top-down, paternalistic and inflexible manner, and hence were not responsive to the needs and demands of clients (Umali & Schwarz, 1994; Rivera, 1991; Wilson, 1991; Le Gouis, 1991; Rivera, 2000). As we have argued, the need for change in the Netherlands had different origins, and derived essentially from the breakdown in the societal consensus about the direction of agricultural development. All this at a point in time where politicians set out to reduce government and put innovation explicitly on the political agenda. In many ways 'privatization' happened to be an attractive and timely policy discourse from which solutions could be selected. With the identification of privatization as an interesting option for leveraging change in the knowledge infrastructure, economic concerns and terminologies (such as efficiency, economic goods, supply and demand, knowledge markets) entered the policy arena. This development went parallel with and was stimulated further by the debate on innovation in which the linear model was contested ever more and the role of users (the demand side) in innovation processes was stressed. This was visible in for instance the pressure on TNO, the largest Dutch public R&D organization to become more market oriented and to acquire more contracts from firms. In many OECD countries we saw more or less similar developments (Smits, 1997).

Knowledge as an economic good

The competitive advantage of companies and sectors is increasingly seen as depending on the quality and timely use of the knowledge and ideas of those who work in it (Ministry of Education and Sciences, 1979, Freeman, 1987, Den Hertog & Smits 2004, Nelson & Winter, 1977, World Bank, 1998; FAO & World Bank, 2000; Little et al., 2002). In line with this, knowledge and information are often regarded as economic goods.

From the viewpoint of economic theory, it is possible to identify four basic types of goods along two dimensions (Umali & Schwarz, 1994). The first dimension is 'subtractability' (or 'rivalry'), which refers to the extent to which one persons' access to a good or service reduces its availability for others. When, for example, there is only a certain amount of fish in a lake, the catches of one fisherman limit the availability of fish for others. Hence, fish in a lake constitutes

a 'high subtractability' good. The second dimension is 'excludability' which refers to the extent to which mechanisms are in place that reserve access to a good to some, excluding others. When, for example, social mechanisms are introduced that effectively prevent the number of fisherman (or nets) to increase, we can say that fish becomes more excludable. The four basic types of goods and services associated with these dimensions are presented in Table 1. As can be noted from the table, the various goods tend to be associated with different ownership arrangements as well.

		<i>Excludability</i>	
		Low	High
<i>Subtractability</i>	Low	Public Goods (collective or non-property which is abundantly available for all) e.g.: <ul style="list-style-type: none"> • air for breathing; • daylight; • a public radio station; • a national animal disease prevention strategy; 	Toll Goods (an individual or group property that can be used by others who are granted access and/or pay a fee) e.g.: <ul style="list-style-type: none"> • a toll road; • an agricultural exhibition; • a website accessible for a fee.
	High	Common Pool Goods (collective or non-property that is available to all until supply runs out) e.g.: <ul style="list-style-type: none"> • fish in an unprotected lake; • grazing area in a communal land; 	Private Goods (a property that can be 'owned' by individuals, often after paying a price) e.g.: <ul style="list-style-type: none"> • an individual fishing right for a demarcated fishing ground; • private grazing land; • a bag of fertilizer; • tailor-made veterinary advice.

Table 1: Four basic types of goods and services according to economic theory (based on Umali & Schwarz, 1994; see also Beynon, 1998; Katz, 2002).

It is important to keep in mind here that the same material good can take on a different nature, depending on the specific context (e.g. scarcity) and social arrangements, and the ways in which actors deal with them. Agricultural land, for example, is nowadays a 'private' good in the Netherlands, but in other settings it may be a 'common pool' or 'toll' good. Similarly, agricultural advice can at one point in time be organised as a 'public' or 'common pool' good, and later be re-organised into a 'private' good. Thus, the nature of a good (public, private, toll or common pool) is -to a considerable extent- a matter of societal choice.

From the perspective of this classification, it can be noted that 'knowledge' (in its mental capacity) is inherently characterised by a low subtractability, since its 'quantity' does not diminish once it is shared with others (if anything, it increases). To a lesser extent, the same holds for 'information', which can be defined as 'knowledge expressed in a tangible form' (e.g. in a book, leaflet, website, simulation model, etc.). Clearly, information can be more subtractable than knowledge in its mental capacity; the number of books or leaflets available, for example, can be limited. However, with the help of arrangements like copying machines, libraries and Internet much can be done to keep subtractability low, and/or frustrate attempts to make information subtractable. In relation to excludability, we can assess that knowledge and information are not necessarily excludable, but that mechanisms to this effect can be relatively easily invented. People can, for example, be denied to receive certain services (e.g. expert advice, an agricultural journal, up-to-date market information, and/or access to a television channel or website) unless they are prepared to 'pay' in money or kind. Similarly, the usage of specific knowledge can be effectively limited or made subject to payment by means of patenting systems. From the above we can conclude that turning these classical forms of knowledge and information into 'commodities' is often most feasible by increasing their 'excludability', thus turning them into toll goods. In addition, knowledge can be incorporated and applied in physical products like seeds, machines, pesticides etc. In that form, 'knowledge' indeed becomes both easily excludable and subtractable, and hence can be easily converted into a private good.

Finally, it is important to realise that in the context of innovation processes, knowledge and information products are only rarely well described and 'sold' in a straightforward manner. This can happen e.g. in the case of technologies, patents, books or computer software, but in many instances we see that it is unclear in advance which knowledge will be needed and prove relevant in a certain context, while at the same time we know that in any situation much relevant knowledge is implicit and difficult to explicate and formalise (Giddens, 1984; Scott, 1998; Nonaka & Takeuchi, 1995). This type of knowledge often is referred to as tacit knowledge. We often see, therefore, that it is not so much a clearly described knowledge product that is sold, but rather a much more loosely described service that is embodied in a person (or organisation) that is known to have (access to) certain experience, knowledge ability, skills, credibility and trustworthiness. Such services can take the form of an advisory visit or consult, supervision of

a change trajectory, collaborative inquiry and research, etc. etc. Therefore, we will speak from hereon about 'knowledge intensive innovation support (KIIS) services' rather than of 'research and extension' (see also Müller & Zenker, 2001; Smits, 2002)

The pro's and con's of markets

According to mainstream neo-classical economic theory, a 'perfect market' is in principle the most efficient way of exchanging goods and services. 'Efficient' here means that the supply and demand of goods is optimally balanced, whereby users can obtain the best quality product given the price that they are willing to pay. Important conditions for this to happen, however, are that there are sufficient competing suppliers of the same good (perfect competition), and that users have adequate information about the prices and qualities of goods and services (perfect information). In many instances, such conditions are not met; i.e. markets are 'imperfect'. Even so, it frequently happens that development policies (including agricultural and resource management policies) are based on the assumption that markets are perfect, which leads to all sorts of problems with regard to their effectiveness (Baland & Platteau, 1996; Stiglitz, 2002). Typically, policy oriented economists have responded in two ways to the widespread occurrence of such 'market failures'. Many maintain the normative ideal of a perfect market, and argue that in the case of 'failure' the obstacles to perfect competition and perfect information should be removed. An increasing number of economists, however, argue that the assumptions underlying neo-classical economic theory (e.g. that people make rational calculations of costs and benefits) are far too simplistic, and that new -less normative- theories are needed to explain why economic behaviour occurs as it does. In this line of thinking, deviations from neo-classical theory are no longer rejected as 'imperfect' or a 'failure', but rather seen as phenomena in their own right that may also have positive qualities. In particular, such economists argue that a much better understanding is needed of the functioning of economic institutions (Williamson, 1998; Ménard, 1995; Baland & Platteau, 1996), including 'non-market' arrangements for exchanging goods and services. This is not the place for an in-depth discussion of economic theory. Suffice to say that -even from the perspective of economic theory- 'markets' are not a panacea, and that there may be good reasons for exchanging goods and services through other arrangements than markets such as, for example, organised bodies, informal networks, distributive rules, etc. As Van der Hamsvoort et al. (1999) point out, the transaction costs necessary for organising excludability and/or subtractability of goods -as preconditions for a market to operate- may be excessively high in comparison with the benefits incurred. In a given context, for example, the technical and/or administrative costs for making people pay for

listening to radio can exceed the expected benefits. Also, the societal costs can be high, as particular groups may be excluded from the product, which may be deemed undesirable especially in the case that there is a public benefit for widespread provision of the product (i.e. the merit good argument, one of the arguments against patents). According to Van der Hamsvoort et al. (1999) the key advantages of introducing market arrangements for goods that used to be provided by the state (in their case 'nature and landscape') are typically that (a) the government can reduce costs, (b) one can expect a better connection between supply and demand, and (c) providers of goods can diversify their sources of income, and reduce risk. As risks they mention that (a) the provision of certain goods may be endangered as they will be substituted by goods that are easier to market (substitution risk), (b) clients will obtain goods elsewhere where no market has been organised (relocation risk), (c) certain groups will be excluded (exclusion risk), and (d) providers may incur losses and go bankrupt (market/continuity risk).

New arrangements and roles for government: counteracting market failure

To counteract the kinds of risks mentioned above, continued state involvement in the provision, financing and/or regulation of KIIS services is deemed necessary and justified. This is in line with the 'merit good' argument. The 'merit good' argument is at the basis of the discussion of the need for continued state involvement in KIIS service provision. The decision what to privatise, and how to privatise is always a political decision (WRR, 2000). The state has to assess and decide for which citizens' interests the state wants to take responsibility and through what arrangement. This discussion goes beyond the pure economic characterisation of goods and deals with the determination of the social relevance of the provision of goods and services, irrespective of their public or private nature. One can speak of a public interest when the state is concerned with the fulfilment of certain interests based on the conviction that otherwise this interest is not addressed sufficiently. The state has to esteem whether a good can be distributed satisfactorily via the market, or that the provision of the good via the market sets off, as mentioned above, manifestations of market failure. These manifestations of market failure include negative externalities, information asymmetry, unequal access and high transaction costs. The prevention of market failure asks for continued state intervention in the provision of goods that are in the public interest (WRR, 2000; Beynon et al., 1998; Carney, 1998¹).

Dominant present thought is that KIIS service provision is a pluralistic affair, with intermingling funding and provision by both public and private parties, existing or new, so that a complete and complementary range of KIIS services emerges (Carney, 1998; Katz, 2002; Rivera et al., 2002; Neuchâtel Group, 1999). In this context Den Hertog et al (1998) introduce the concept of the 2nd order knowledge infrastructure² in which knowledge intensive business services

¹ See Beynon et al. (1998: 22-24), and Carney (1998: 44-45) for elaborate descriptions of market failure specifically related to 'extension goods'

² The 1st order knowledge infrastructure is the infrastructure as we know it already for decades in which exists a sharp

(KIBS) play an important role in the identification, translation and, by, this in the provision of tailor made knowledge for various types of users. Within such a system, state intervention can be aimed at promoting the public interest and assuring social welfare through ensuring the delivery of specific services to specific audiences (Carney, 1998; WRR, 2000; Katz, 2002), and/or by exercising control over the quality of private KIIS service provision (Currell et al., 2002). In the Netherlands we see that the state still funds particular KIIS activities on a 'public funding, private delivery' basis (Zijp, 1998). Public funds for KIIS service provision can be channelled to end-users either directly or indirectly (Katz, 2002). The direct way, demand-side financing, consists of giving funds directly to the end-users of KIIS services, either in vouchers that represent a certain monetary value (see e.g. De Grip & Leeuwis, 2003), or through refunding investments after proof of an actual transaction between the KIIS service provider and the farmer. In this way the state remains -relatively speaking- at a distance. The indirect way, supply-side financing consists of outsourcing or contracting-out services to private companies, who then execute a service mandate for the state. This essentially means that the state becomes a client (cf. Leeuwis, 2000; Wielinga, 2000).

In addition the state can mobilise several 'safeguarding instruments' in order to exert influence on the nature and quality of services delivered by private extension organisations (regardless of whether these services are publicly or privately funded). Three such safeguarding instruments are available: (1) promoting competition between different providers, (2) setting of legal rules and contracts, and (3) promoting institutional responsibility and product quality (WRR, 2000). Thus, the state becomes essentially a client and/or a market supervisor.

distinction between knowledge providers and knowledge users.

4. Discourse 2: Changing views of innovation and innovation support

The second body of thought that is relevant to the debate on 'new knowledge arrangements' derives from innovation studies.

Working towards successful combinations of hardware, software and orgware
Over the years, ideas about innovation and change have evolved considerably. The earlier mentioned linear model of innovation has been refuted and criticised by many (Kline & Rosenberg, 1986; Rip, 1995; Röling, 1988, Leeuwis, 2004b). When one analyses successful innovation processes in retrospect, it is apparent that many ideas originate from practical experience and that the role of science is often limited. Successful innovations appeared to be based on the effective integration of the problem perceptions, goals, knowledge and experience of scientists, clients, intermediaries and other parties involved. In this vision a sharp difference exists between R&D policy and innovation policy. Although they partly overlap, the first is about the production of new knowledge, the latter about the exploitation of, sometimes already long existing knowledge. The difference also becomes clear when looking at the people involved. Einstein, Planck and Curie are actors involved in R&D policy, Ford, Gates and Iacocca in innovation policy. These two types of policy also differ with respect to the instruments used. Examples of R&D policy deal with the allocation of research funds and the transfer of knowledge, innovation policy instruments with articulation of demand and the building of networks necessary to develop innovations (Smits, 2004).

Not only have the ideas about the origin of innovation changed, but also the ideas about what an innovation actually is are susceptible to transformation. In the past an innovation was regarded as a 'simple' technological device. Moreover, the idea was that an innovation was either adopted or rejected by an individual, depending on all kinds of social conditions, among other things (Rogers, 1983). It was thought that a new crop variety, for instance, could only be successful on the condition that certain input and output markets were adequately organised. Nowadays, we look at innovation differently. In the first place we recognise that innovations -even when considered solely from a technical perspective- are not one-dimensional, but must be viewed as large collections of partial innovations. Secondly, we do no longer regard the social and organisational conditions as external and static, but rather as integral parts of any innovation. Innovations do not just consist of new technical arrangements, but also of new social and organisational arrangements, such as new rules, perceptions, procedures, agreements and social relationships (see e.g. Smits, 2004; Van Schoubroeck, 1999; Kuipers et al, 2005). Thus,

innovation depends almost always on multiple stakeholders, which implies that it is no longer useful to look at 'adoption' as something that happens at an individual level. What is important are the co-ordination and interdependencies between social actors. In line with this, Smits (2000, 2002) defines an innovation as: "... a successful combination of hardware, software and orgware, viewed from a societal and/or economic point of view".

Hardware relates to the material equipment (mostly) involved (new machinery to produce specialties) and software concerns the knowledge in terms of manuals, software, digital content, tacit knowledge involved in the innovation (dedicated software, new types of management and organisational designs necessary to produce the specialties). Orgware refers to the organisational and institutional conditions that influence the development of an invention into an innovation and the actual functioning of an innovation (new regulation, market development, organisational and material infrastructures). As argued by Kuipers et al. (2005), the orgware and software dimensions of innovation are often overlooked by technical scientists as critical components of successful innovation design.

Finally, the thinking about innovation as a process has also changed dramatically over the past decades. In former days there was a strong belief in the possibility of planning and predicting change and innovation. In contrast, we now see that change is affected by complex interdependencies, fundamental uncertainties, chaos, unintended consequences, conflicts and unpredictable interactions that can not be understood from a reductionistic perspective (Prigogine & Stengers, 1990). In connection with this, innovation processes are looked at nowadays from an evolutionary perspective. The idea is essentially that a variety of innovations and innovation processes compete in a dynamic selection environment in which the 'best fitting' survives (Bijker et al., 1987; Rotmans et al., 2001, Nelson & Winter, 1977).

A process view of innovation support

If we understand innovation as new combinations of 'hardware, software and orgware' three (simultaneous) processes deserve particular attention when supporting innovation processes:

Network building

The first process is that of the building of networks (Callon, 1986; Callon et al., 1992). Innovation requires co-ordinated action within a network of people. Such a network does not just come into existence; it needs to be 'constructed'. And because renewal and innovation are at issue here, it will be evident that there is often a need for the forging of new relationships, both in terms of the parties involved and in terms of content (Engel, 1995), and for using these to expand windows of opportunity.

Social learning

At the same time that the building of a network is taking place, something that can be described as a social learning process must also occur. This means that the parties involved slowly develop overlapping -or at least complementary - goals, insights, interests and starting-points (Röling, 2002), and identify actions that embody 'congruency' (Grin & Van de Graaf, 1996; Van Est, 1999).

The term 'learning' is used in different settings (varying from schools to societal innovation processes), but is often not clearly defined. Commonly, people would say that 'learning' has occurred when there is evidence that individuals or groups have changed their knowledge and understanding about the state or functioning of social, economic, bio-physical or technical systems. When looking at (system-) innovation as a phenomenon whereby different actors start to coordinate their practices in a different way, it becomes clear that other forms of perception and perceptual change need to be considered as well. Sociological and social-psychological theories (Ajzen & Fishbein, 1980; Bandura, 1986) suggest that what actors do and do not is not just influenced by their knowledge, but also by perceptions regarding their own (and other agents') aspirations, capacities, opportunities, responsibilities, identities, duties, etc. (see Figure 2).

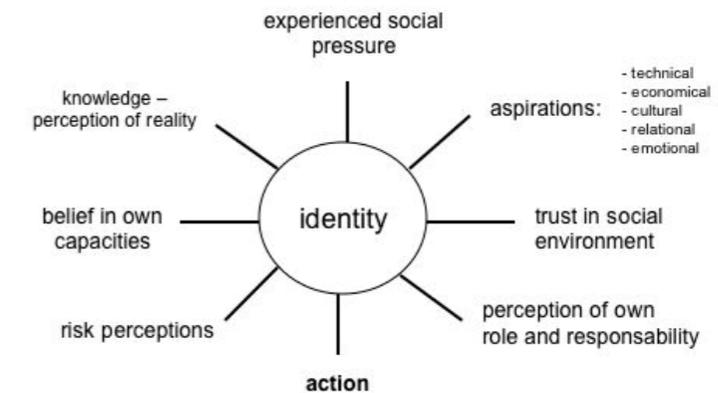


Figure 2: Different areas of perception (reflecting simultaneously reasons for action) that may be subject to 'learning' i.e. perceptual change (Leeuwis, 2004a; adapted and expanded from Röling, 2002; Leeuwis, 2004b).

When deciding about whether or not to shift to organic farming, for example, a farmer may (consciously or not) consider: the existence of a relationship between organic farming and environmental sustainability (knowledge), the negative attitudes of neighboring farmers (social pressure), the availability of sufficient knowledge and skills to succeed as an organic farmer (belief in own capacities), the reliability of supermarkets and consumers in buying produce (trust in social environment), and how organic farming will affect (the balance and trade-offs between) important aspirations such as income, spare time, peace of mind, good relations with the neighbors, etc. In view of the above we define learning more broadly as involving a change in any of the perceptions indicated in Figure 2. That is, a change in the reasons that shape human practices. In line with the earlier presented definition by Rölting, social learning can be seen to have occurred when different actors more or less simultaneously change their 'mindset' (i.e. the 'software' component of innovation) in such a manner that it leads to effective coordination of action towards innovation.

Negotiation

A third process is that of negotiation and conflict management. Innovation implies changes in the status quo, which is always accompanied by friction and tension, especially in the case of innovations that go further than just optimisation within established frameworks and goals. Such innovations, which are characterised by the letting-go of existing starting points, goals and assumptions and imply a change in both action and the structure in which it takes place are also known as 'system innovations' or 'transitions' (Rotmans et al., 2001; Geels, 2002; Grin, 2004). This kind of innovation and change involves also changes in the technological regime or, more accurately, in the socio-technological regime (Rip & Kemp, 1998; Geels, 2002) and thus brings with it conflicts of interest between the parties involved and also with the established social and technological system or 'regime' that in many ways needs to be 'conquered' (Rip, 1995). In order to deal with such tensions, and in order to make new agreements and social arrangements, negotiation is essential. Preferably integrative negotiation based on a social learning process (Aarts, 1998), and involving strategically relating niche experiments, the regime and exogenous developments to each other so as to foster change. (Roep et al. 2003; Grin et al., 2003; Grin, 2005).

Innovation systems and systemic instruments

As indicated earlier, there is a long tradition in the agricultural sciences to speak about Agricultural Knowledge and Information Systems (Nagel, 1980; Rölting & Engel, 1990) as a set of institutions that is geared to support innovation in the sector. Outside agriculture, the term Innovation Systems reflects similar ideas, as is reflected in Metcalfe's definition of Innovation Systems:

"A system of innovation is that set of distinct institutions which jointly and individually contrib-

utes to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artifacts that define new technologies". (Metcalfe, 1995)

In the pre-privatization period we can indeed speak of a 'system' that was deliberately designed, organized and - to some extent centrally managed- to work in a synergistic manner (even if such synergy was not always achieved). After the privatization, we see that the number and kinds of organizations involved in innovation support and KIIS services has grown considerably, and that connections between these organizations have become much more loose and temporary. Moreover, consensus about the direction of desired innovation has diminished considerably. In this context, the word 'system' has become questionable as a descriptive term, even if the ambition of the government remains to enhance a system-like functioning of the knowledge infrastructure. Not surprisingly, therefore, later writings in the sphere of agricultural innovation systems tend to speak of networks and configurations rather than of systems: "Over time networking may lead to the gradual development of a pattern of more or less durable relationships among a number of social actors who perceive each other as relevant to (some of) their concerns. Such innovation configurations harbour the accepted views, procedures and ground rules for collective behavior with respect to (a particular type of) innovation. In such configurations, convergences, resource coalitions and communication networks³ come to coincide enough to make strategic consensus, a clear definition of tasks and responsibilities and a rational allocation of resources possible" (Engel, 1995:261).

From the innovation systems literature it is clear that innovation systems may well fail to effectively support innovation (including system innovation and transition, see Rotmans, 2003). In this context, Jacobsson & Johnson (2000) speak of 'system imperfections'. In part such imperfections derive from the existing socio-technical regime in the societal system in which innovation is strived for (e.g. the energy system), which does not support or even actively resist transformation. In connection with this, 'system imperfections' may also occur in the knowledge infrastructure itself (Grin et al., 2004). Such system imperfections, then, provide the legitimacy for governments to develop innovation policies and the like. As part of such policies, Smits & Kuhlmann, (2004) argue that governments to complement the traditional policy instruments portfolio focusing on individual organizations and/or bilateral relations (transfer), should invest in the following systemic instruments:

³ Convergences emerge when social actors narrow down the scope of their arguments, along with the range of issues and alternative scenarios they consider relevant to innovation in their practices. Consensus must be seen as the exception. Resource coalitions emerge when social actors decide to pool their resources in a joint performance. They are a result of strategizing by social actors who use their assets to enroll others in their 'projects'. Communication networks emerge as a direct consequence of social actors' decisions to create joint learning opportunities and to produce and exchange information among themselves. (Engel, 1995; pp.148-150)

(a) The management of interfaces

This management not only aims at transferring knowledge but also at building bridges and stimulating the debate.

(b) Building and organising (innovation) systems

Construction (Neue Kombinationen) and deconstruction (creative destruction) of (sub) systems, initiate discourse, alignment, consensus. Also the management of complex systems, prevention of lock-in, identification and facilitation of prime movers and ensuring that all relevant actors are involved, are part of this function. As in illustration for the case of energy systems we refer to Jacobsson & Johnson (2000).

(c) Providing a platform for learning and experimenting

Create conditions for various forms of learning such as: learning by doing, learning by using and learning by interacting (Rosenberg, 1982, Lundvall, 1992).

(d) Providing an infrastructure for strategic intelligence

Identify sources (Technology Assessment, Foresight, Evaluation, Bench Marking) build links between sources, improve accessibility for all relevant actors (Clearing house) and stimulate the development of the capacity to produce strategic information tailored to the needs of actors involved (Kuhlmann, et al, 1999).

(e) Stimulating demand articulation, strategy and vision development

Stimulate and facilitate the search for possible applications, develop instruments that support discourse, vision and strategy-development. This last point, as is point 4, is further illustrated by the growing body of knowledge on the role of users in innovation processes (Oudshoorn & Pinch, 2004, Smits & Leyten, 1991).

As can be noted, there is strong emphasis on knowledge, debate, experimentation, strategic intelligence and vision development in the 'systemic instruments' distinguished by Smits & Kuhlmann (2004). We can say therefore, that 'systemic instruments' can be seen as contributing to social learning.

The changing role of communication specialists

In the linear model of innovation, communication mainly was regarded as a mechanism for enhancing the adoption and diffusion of innovations by individuals. Communication specialists were seen as 'extensionists' who organized their work in the form of persuasive technology transfer campaigns, advisory communication and the support of horizontal communication among farmers. The new concept that innovation is about fostering new forms of coordinated action among multiple stakeholders, has important implications for the role of communication specialists. It implies that the conventional repertoire of 'extension' forms needs to be supplemented with other modes of communicative support aimed at building networks, developing shared visions and understandings, facilitation of conflict management, capacity building,

performing roles consistent with the idea of 'systemic instruments', etc. Such modes of process support in collaborative innovation design can be captured under the term 'facilitation'. From theories about network building, social learning and negotiation several important facilitation tasks can be derived (see Box 1: Tasks in integrative negotiation processes (derived from Van Meegeren & Leeuwis, 1999)).

Task 1: Preparing the process:

- Preliminary exploratory analysis of conflicts, problems, social (including power) relations, practices, etc. in historical perspective;
- selecting participants;
- securing participation by stakeholders;
- establishing relations with the wider policy environment;

Task 2: Reaching and maintaining process agreements:

- creating an agreed-upon code of conduct and provisional agenda;
- preliminary establishment of an overall objective / terms of reference;
- provisional distribution of facilitation tasks;
- definition of the role of external facilitators and other outsiders;
- maintaining process agreements;
- securing new process agreements as the process unfolds.

Task 3: Joint exploration and situation analysis:

- supporting group formation and group dynamics;
- exchanging perspectives, interests, goals;
- further analysis of conflicts, problems and interrelations;
- integration of visions into new problem definitions;
- preliminary identification of alternative solutions and 'win-win' strategies;
- identification of knowledge conflicts and gaps in insight.

Task 4: Joint fact-finding and uncertainty reduction:

- developing and implementing action-plans to fill knowledge gaps and/or to build commonly agreed upon knowledge and trust.

Task 5: Forging agreement:

- supporting manoeuvres: clarifying positions and claims, use of pressure to secure concessions, create and resolve impasses;
- soliciting proposals and counter-proposals;
- securing an agreement on a coherent package of measures and action plans.

Task 6: Communication of representatives with constituencies:

- transferring the learning process;
- 'ratification' of agreement by constituencies.

Task 7: Coordinated action:

- implementing the agreements made;
- monitoring implementation;
- creating contexts of re-negotiation.

The proposed tasks (and the guidelines associated with these, see Leeuwis, 2004) are based on the idea that an innovation process can be organised along the lines of a negotiation process, in which special attention is paid to the facilitation of social learning (articulation of demand for instance). Some of the tasks mentioned are especially important during the early stages of an innovation design trajectory, whereas others become important while the process proceeds. However, all tasks remain relevant throughout the process as many iterations are likely to occur. Thus, the overview of tasks should not be interpreted as 'stages' or 'phases', and neither must they be regarded as being performed by a single person and/or external facilitator.

In the context of 'transition management', Rotmans (2003) and Van Staveren & Grin (forthcoming) offer somewhat different approaches, steps and tasks that are to be facilitated as part of ambitious innovation trajectories. However, it is clear that both the views of Rotmans about transition management and Smits & Kuhlmann's proposal for developing systemic instruments, imply a radical breakaway from the original roles that communication specialists were supposed to play. Facilitation of social learning transpires as a core common denominator.

The changing role of science

An implication of the altered ideas about innovation is that, contrary to the ideas instilled by the linear model, innovation is not primarily about 'doing scientific research' (see also Leeuwis & Remmers, 1999). Science can be rather strong at analysing what happened in the past, but is weak in composing, or synthesising, the future (Remmers, 1998:321ff). Innovation is essentially synthesis, research is essentially analysis, but doing research and gathering data can include interactions between researchers and stakeholders that imply learning moments for both. Thus, scientific insight and investigation can play an important role in social learning processes and joint fact-finding within a context of negotiation (Van Meegeren & Leeuwis, 1999). But innovation processes are not likely to be successful if they are scientist owned and/or initiated (Leeuwis, 1999a; Broerse & Bunders, 1999). In a learning and negotiation process, knowledge generated in various locations (e.g. research stations and farmers' fields), by different stakeholders (e.g. researchers and farmers), for dissimilar purposes (e.g. assessing the 'truth' and promoting stakeholder interests) and through different procedures of validation

(e.g. scientific method and farmer experience) must be creatively articulated and integrated. In innovation processes, then, scientists can be seen as resource persons. Since the breakdown in the dominant consensus regarding agriculture, they are operating increasingly in complex situations where uncertainty is high and where different values and interests are at stake. In such situations, in which different policy views and different knowledge claims contest each other, 'boundary work' is needed in order to arrive at 'serviceable truth' (Jasanoff, 1990; cf In 't Veld, 2001; Hoppe & Huys 2003). One form of boundary work that may be of particular interest here is Funtowicz & Ravetz's (1993) 'post-normal' approach to science, instead of a strategy in which science is only applied for the 'solving of puzzles' or the giving of situation-specific advice. With post-normal science, scientists are intensely involved in societal processes, debates and innovation. In other words, in processes of network building, social learning and negotiation. In a similar vein, Gibbons et al (1994) speak of the need for scientists to shift from 'Mode 1' to 'Mode 2' science (see Table 2).

MODE 1 SCIENCE	MODE 2 SCIENCE
Academic context	Application-oriented
Disciplinary	Trans-disciplinary
Homogeneous	Heterogeneous
Hierarchic and stable	Heterarchic and variable
Academic quality control	Quality measured on a wider set of criteria
Accountability to science	Accountability to society too

Table 2: Key differences between Mode 1 and Mode 2 science as described by Gibbons et al. (Smits, 2002, based on Gibbons et al, 1994).

Operating in a 'post-normal' (or Mode 2) manner has important implications for scientists. When looking more in detail at the role of scientists we can discern four basic roles with regard to knowledge:

- (1) help explicate implicit assumptions, knowledge claims and questions: Discussions among stakeholders usually contain a range of implicit knowledge claims, assumptions and questions. Frequently, progress in social learning and negotiation processes is hampered when these remain implicit and do not become a point of explicit discussion and reflection. Such explication is far from easy and can never be complete. Nevertheless, not only process facilitators, but also scientists from different disciplines can play a useful role in this respect. One may expect from scientists that they have a special sensitivity for the assumptions, knowledge claims and questions that are hidden in what stakeholders say or do not say about their specific field of expertise. Hence, dialogue between stakeholders and scientists may contribute

to making explicit what was implicit previously, and result simultaneously in a coherent set of relevant natural and social science questions.

- (2) joint fact-finding and uncertainty reduction: Research can play a role in joint fact-finding geared towards answering shared questions and reducing uncertainties that affect the innovation process. The purpose of this type of -natural and/or social science- research is not only to provide answers, but also to build confidence, trust and shared perspectives among stakeholders by working together on an issue in the first place (Van Meegeren & Leeuwis, 1999). Depending on the questions addressed such research may involve on-farm research, laboratory research by scientists, computer simulations etc., as long as it remains part of a commonly agreed upon -and preferably iterative (see Vereijken, 1997)- procedure. In the context of such research, scientists also need 'free space' to follow their own intuitions (see Van Schoubroeck & Leeuwis, 1999).
- (3) feedback on problems and opportunities: Results from research can serve as -more less confrontational- feedback in order to induce learning, i.e. through the creation of new problem definitions and/or by the identification of unrecognized opportunities. Such feedback from natural and/or social scientists may be provided by research data on the existing situation, but may also arise from comparison with totally different situations (including laboratories), from insights regarding different scale levels and/or from computer-based projections about the future (Rossing et al., 1999; Röling, 1999). This can also include comparison with radically new technological and organisational solutions. These latter kinds of feedback may serve to enlarge the space within which solutions are searched for. Given that scientists' questions, concerns and conclusions are never neutral (see Leeuwis, 2004), it is important that -when giving feedback- scientists are transparent and explicit about the implicit dimensions (e.g. underlying aspirations and assumptions) of the knowledge and insights they provide (Alrøe & Kristensen, 2002). Such transparency does not imply that scientists become 'politicians'. On the contrary, when scientists are aware of their underlying aspirations and values it becomes clear that clashes between interests can not be resolved by scientists, but that it is the task of societal stakeholders, administrators and politicians to value and appreciate the insights put forward and make choices.
- (4) reflexive process monitoring: Research can play a role in monitoring the social dynamics of the learning and negotiation process itself, as well as the structural context, in order to inform its organisation and further facilitation (Weterings & Grin, 2005). The term reflexivity literally means 'feeding back onto itself and is used to indicate that the monitoring approach should be designed, among others, to influence (enhance) the innovation process under study and/or the structural conditions under which it takes place (Forester, 1999).

In addition to these still highly knowledge-oriented tasks, scientists may also (need to) assume responsibility for tasks related to process facilitation and management (see Leeuwis, 2004), play a role in mediating questions to relevant expertise elsewhere, and help in securing financial and other resources to further joint fact-finding.

Playing a role as outlined above requires different modes of operation by scientists than are currently dominant. It requires, for example, (a) intensive cooperation between stakeholders, change agents and researchers, (b) cross-disciplinary cooperation among scientists (as the solving of problems may well involve integration of insights from various disciplines), (c) greater emphasis on on-site experimentation, (d) new procedures for setting research agenda's, etc. (see also Bouma, 1999; Van Schoubroeck & Leeuwis, 1999; Vereijken, 1997). Current organizational set-ups, epistemic cultures, competencies, assessment procedures, funding arrangements and other reward systems within universities and research institutes are often not conducive to such new ways of working (see Grin et al., 2004; Leeuwis, 2004) which signals a need for system change in the knowledge infrastructure itself (which indeed is one of the objectives of BSIK programs such as TransForum). One of the main barriers to overcome is a change in the reward system of scientists that until today is heavily dominated by the scientific peer review system that tends to keep scientists away from interaction with stakeholders outside the science system.

5. The quest for new arrangements: toward an inventory and an assessment

We can conclude that political, financial and organizational conditions in the agricultural knowledge infrastructure have altered considerably. The above discourses suggest that new knowledge arrangements are needed in four (closely intertwined) spheres:

- (a) in the sphere of the knowledge intensive innovation support services (including the related Knowledge Intensive Business Services) that are being provided and/or deemed necessary, such as systemic instruments, facilitation services and new role descriptions for knowledge workers;
- (b) in the financial sphere, where new procedures for supply-side or demand-side funding of services are being developed, involving among others voucher systems, tendering and bidding procedures for contracting, and also new public/private funding and share-holding constructions;
- (c) in the sphere of supervising the market for KIIS service delivery, involving among others new legislation and quality control systems;
- (d) in the sphere of creating internal institutional conditions that will allow universities, research institutes and other organizations involved in service provision to work effectively in the new environment;

In each sphere we have indeed witnessed considerable experimentation and dynamics in the past decade or so, initiated by government, knowledge institutions and private parties. It certainly is too early to say that the situation has crystallized to a more or less stable and recognizable pattern, as new arrangements appear and disappear on a regular basis. New arrangements for cooperation and intervention that have drawn the attention in recent years include:

- regional innovation networks;
- interactive research projects for designing sustainable farming systems;
- DLO 'system-innovation' and 'network' programs;
- public/private liaison organisations such as Knowhouse;
- public/private transition support programs such as TransForum;
- agro-cluster academies and related initiatives;
- Mineral Management Liaison Service and voucher scheme;

- establishment of intermediary organizations such as Nido and Innovatienetwerk;
- knowledge cooperation;
- syntens.

The abovementioned arrangements differ greatly in terms of their mission and role perception, funding and ownership structure, approach, function, and time horizon. However, systematic descriptions and evaluations of these arrangements are lacking largely; it is proposed that these will be developed as part of the research program of TransForum.

6. Initial observations regarding the functioning (strengths & weaknesses) of the current innovation system

It is not easy to make well-founded statements about the functioning of the current knowledge infrastructure that is supposed to enhance innovation in agriculture and other forms of land-utilization. On the one hand this is related to the fact that the situation is far from stable and has not crystallized yet; new developments are taking place on a regular basis. We currently witness, for example, intensified efforts by the Ministry of Agriculture (and the EU) to shift from supply-side financing (with the government and other users in the role of client) to demand-side funding by means of vouchers, whereby societal stakeholders get greater control over the spending of available public money. Another obstacle is that systematic comparative research on the functioning of new arrangements is almost absent. When outlining some strengths and weaknesses of the functioning of the knowledge infrastructure, therefore, we need to rely on occasional research reports, participant observation and informal discussions with actors involved. On the basis of this, we will discuss some tendencies that may be characterized as 'positive', and a rather larger number of problematic issues.

'Positive tendencies'

Considerable dynamism and experimentation.

It is important to signal that there is considerable dynamism in the agricultural knowledge infrastructure. New arrangements and institutions are being tested in order to find ways of dealing with the radically changed situation. There is considerable diversity in terms of the arrangements that are experimented with, which is positive when looked at from an evolutionary perspective. One can assume that, eventually, the 'best fitting' arrangements will be consolidated and survive. The question of 'what' and 'who' such arrangements will fit best is difficult to answer at this point in time.

Re-regionalization of the knowledge infrastructure

In the period immediately after privatization we have witnessed a significant centralization of especially applied research. Quite a number of regional research stations and experimental farms were closed down in the process of reorganisation. Thus, an important element of the old EER tryptich 'disappeared' from the local scene, and it is reasonable to assume that this has led to a decrease in informal contacts between applied researchers and local farmers. More

recently, however, we witness that new regional intermediary institutions are emerging that may play a role in restoring contacts between local initiatives and research.

Increased interactivity.

While the old EER tryptich was designed to work in a rather linear manner (even if informally it was selectively interactive), we see that new knowledge arrangements have adopted a much more interactive and participatory language and philosophy. Indeed the impression is that projects and programs invest more in interaction with societal stakeholders when designing and implementing activities. This is important from the viewpoint that innovation is something that happens in society, which indeed implies that one cannot expect to contribute to innovation without some serious involvement of societal parties and network.

Involvement of new categories of stakeholders

One can observe that new knowledge arrangements have indeed resulted in some space for non-agricultural stakeholders to become involved in the (increasingly less) 'agricultural' knowledge infrastructure. Representatives of, for example, environmentalists, animal welfare organizations and nature conservationists are now operating in committees that decide about the allocation of funds, and also have become participants in a range of projects and programs. Thus, progress was made regarding the policy objective of opening up the knowledge infrastructure to new parties.

Increased clarity about tasks

An advantage that is frequently mentioned by both clients and service providers is that - in the privatised infrastructure- it is often much clearer and well defined what can be expected from one another, at least when something has been commissioned (e.g. Van Deursen, 2000). This is because there is usually a contract that stipulates, for example, what 'product' is to be delivered, when, and how much time and money is available. Before privatisation, then, such things were often less clear. In fact, expectations could change at any time, so that at times certain activities were 'never' finished and kept dragging on.

Enhanced steering capacity of the government regarding public funds

In the changed knowledge infrastructure the government is no longer the relatively 'distant' co-financier of activities but also -in many instances- the commissioner and client. It is evident that this has increased governmental control and steering capacity over collectively funded research and communicative intervention, which might be considered (at least by some) as positive and contributing to accountability. The government is not only in a better position to decide on the specific themes and topics that need to be tackled, but also in stimulating (and/or enforcing) cooperation between different actors in the knowledge network. This is because such cooperation (along with other demands) can be easily included as a condition

in a tendering procedure. In practice this results in numerous projects and programs in which several partners collaborate.

As we will see below, the aforementioned developments should not be simply regarded as 'positive' as they may have downsides and go along with the emergence of new problems and tensions.

'Problematic aspects'

Limited transparency and accessibility

The re-organization of the knowledge infrastructure has led to a bringing together of many research organizations under the banner of WUR. One might expect that this would increase the transparency and accessibility of the knowledge infrastructure. However, in other respects such transparency and accessibility seem to be reduced. The number of private consultants and advisory organizations (KIIS and KIBS), for example, has increased rapidly. We have also seen that a range of new (often regional) intermediary organizations has emerged. More importantly, we see that partners in a publicly funded project program often present themselves to their clients through (temporary) project identities (e.g. Cows and Chances, Farming with a Future, Mineral Support Service, BIOM, BIOVEEM, etc.), and not through their institutional affiliation. In addition, the easy and open access to research organizations through the omnipresent public extension service has eroded significantly. Despite the concentration of organizations in WUR, therefore, it seems that neither clients nor other members of the knowledge infrastructure have the feeling that there is a clearly recognizable, transparent and easily accessible knowledge infrastructure that has a clear point of entry, accompanied with equally clear procedures for getting something done.

Lack of continuity and coherence

Closely related to the issue of transparency discussed above is the fact that the dominant form of organization in the knowledge infrastructure has become that of a temporarily funded project or program. Such programs and projects tend to come and go, and are almost inherently characterized by limited continuity. Moreover, we see that different government bodies tend to commission a number of distinct projects to different (sub) contractors, but on inter-related themes. In the sphere of mineral management, for example, numerous research and innovation projects came into existence, each with their own target audience, research objectives, time horizon, methodological approach, budget, and participating institutions. Even although these projects could learn a lot from each other, experience learned that it was not easy to foster coherence and coordination among these formally independent projects and implementing institutions (Leeuwis, 2002b).

In addition, we see that new intermediary organisations frequently have difficulty to realise

stable funding. They provide services to both the 'demand-side' and the 'supply-side' in the knowledge infrastructure, and it appears far from easy to arrange payment for such often rather intangible and implicit intermediary services, not least since playing such a brokerage role requires a certain amount of independence. Thus, such intermediaries tend to rely on government subsidies and if these are discontinued, they often fade away (Klerkx, pers. comm.).

Risks regarding pro-activeness and excessive transaction costs

A frequently heard complaint from both farmers and knowledge workers is that "nothing happens unless somebody pays for it" respectively "... unless a bag of money is floating in the air" (i.e. unless a party indicates that money may be available for a certain issue). It is argued that there are situations, issues and problems that demand immediate attention, but for which no adequate funding is yet available. Due to the necessity in commercial organisations to write and allocate working hours to paid projects, then, not much can be done. The non-availability of funds may exist not so much because the issue is not deemed important, but rather because it is not yet on a resourceful institution's agenda, because joint payment is difficult to organise, and/or because there are struggles as to who should pay for it (e.g. on whether an issue should be regarded as mainly 'private' or 'public'). When a government body decides eventually to invest in the delivery of KIIS services, it may take a while before it actually materialises due to a certain level of (market induced) 'bureaucratisation'. In view of national and international laws that regulate free competition, for example, the government is obliged to organise increasingly formal tendering procedures before any major effort can be commissioned. This usually takes a considerable amount of time (not least since fairly precise outputs need to be defined in advance to make a tendering procedure possible), and requires much investment of time from people who eventually will not get the job. Similarly, when researchers, communication workers and/or farmers themselves identify new areas for research and/or service provision, they will have to investigate whether there may be funds available somewhere, and often need to put much effort in lobbying and the (re-) writing of proposals, again with considerable risks of being turned down eventually. All this causes the transaction costs of materialising KIIS services to increase (and sometimes even become prohibitive) when compared to a situation where institutions receive a 'lump sum' and need to decide only on where to put priorities, and justify their activities 'ex-post'. In addition, it leads to an increased proportion of overheads in the tariffs of organisations such as WUR.

In all, we see that under fully privatised conditions it may take considerable time to get new research and communicative intervention activities off the ground, especially when tendering procedures are involved, and/or when many individuals need to organise themselves in order to obtain sufficient funds. This poses risks with regard to the capacity of the network to respond quickly to newly emerging needs and insights.

Risks regarding learning capacity and flexibility

The phenomenon that the 'clarity' with regard to activities tends to increase, also has a down-

side. In a fully privatised 'output financed' system, such 'clarity' is created through the ex-ante formulation of fairly detailed tenders, contracts and/or proposals. Herein things like research questions, objectives, activities, target audiences, contributing parties, participants, time schedules and budget allocations tend to be specified in some detail. The chances are, then, that these are taken too seriously by the parties involved so that they effectively become a 'blue-print'. In essence, we see that in this way rigidities and inflexibility may again be built-in into KIIS service delivery, causing reduced learning and adaptive capacity. One essential characteristic of learning and negotiation processes in innovation trajectories is that it is impossible to predict beforehand what the results will be and which directions for searching solutions will be agreed upon. Room manoeuvres and flexibility are needed -not least in terms of the application of funds- but it has become apparent that this is not so easy to realise in the case of output-oriented financing (see for an example the Mineral Management Support Service; Klerkx et al, forthcoming). Another obstacle towards learning that is referred to (Bartstra, 2001), is that for commercial organisations more in particular, it may be difficult to treat mistakes as learning experiences for all parties involved. This is because admitting mistakes might increase their legal liability, and encourage clients not to pay for 'substandard' services. To conclude, output oriented financing schemes tend to reduce flexibility and by this the space for learning and experimenting.

Increased competition and shielding-off of knowledge.

In a situation where various commercial and/or privatised KIIS service providers need to survive on an ever shrinking 'market' there is bound to be competition. This competitive atmosphere induces that relevant knowledge and insight become strategic resources for organisations, that can not be shared freely, and especially not with (potential) competitors. Especially institutes for applied research and extension organisations (who used to work rather closely together before privatisation) have grown apart because of competition between them. Also, there is much competition between research institutes, even within WUR. Moreover, there are clear signs that farmers and horticulturists have become less willing to show their whole hand when taking part in study groups, partly because they have to pay more and more for KIIS services⁴. The Association of Dutch Horticulture Study Groups (NTS; now LTO Groeiservice), for example, had to compromise considerably on their long-defended ideal of open mutual knowledge-exchange (Oerlemans et al., 1997). Mutual knowledge exchange is further undermined by the phenomenon that the privatised extension service is less inclined -by itself- to support study groups or engage in other group activities. This is not surprising as both the support of horizontal knowledge exchange and the supply of knowledge to a group can be regarded as 'spoiling' one's own market for individual service delivery. Hence, the tendency seems to be

⁴ Another explanation here is that growers have become more involved in specialty products rather than mass production, which has increased competition among them.

that group activities take place only when insisted upon by (governmental) clients. In the current privatised context, cooperation and exchange of experience is no longer easy and the 'normal thing to do', unless one is actually paid to cooperate by a third party and/or when the parties expect that pulling resources might help them to win a tendering procedure. The question is, of course, whether this is beneficial to innovation or not. According to mainstream economic theory competition might act as a stimulus to innovative and client-friendly KIIS service provision. While this may be true in some spheres (e.g. the delivery of individual advice), it is also clear that innovation depends on the integration of knowledge and perspectives from various sources, and thus can benefit from openness and the exchange of knowledge between different parties. From this perspective it is worrying that co-operation and sharing between those involved in the knowledge infrastructure seems to have become less self-evident. To put it differently, privatisation loosens the binding elements in the innovation system in a phase that there is an increasing need for tuning and alignment of the actors involved in the innovation system.

Lack of ownership by societal initiatives

The awareness that innovation processes are really all about new forms of co-ordination between different societal agents must lead us to conclude that innovation takes place primarily within society itself and not just within the artificial boundaries of a project or program. From this perspective, it is important to realise that innovation support efforts are somehow linked to the dynamics of existing innovation initiatives in society, and that societal parties find support activities worthwhile and feel a certain amount of ownership and commitment towards them. This is certainly not always the case. In many instances policy makers and KIIS service providers play a dominant role in defining and shaping programs and projects that are funded with public or collective (e.g.

in the case of product boards) money. This seems to be related to a number of interrelated factors, which together create the conditions under which these parties come to be the main owner of support activities:

- (a) the circumstance that government and policy-makers aspire and are in a position to steer and program innovation trajectories;
- (b) the struggle for resources, which leads institutes to lobby for programs and projects that are congruent with the expertise and potential of the own organisation;
- (c) the circumstance that the owners of societal initiatives hardly play a role in the complex formal and informal discussion and negotiation space that emerges around the formulation of programs, calls for proposals, tendering documents, business plans, etc.;
- (d) the fact that the control over financial resources often remains within the hands of governments and/or those institutions to whom contracts have been commissioned;

- (e) the low quality of demand articulation;
- (f) the conventional way of defining and articulating KIIS supply;
- (g) the continued dominance of knowledge (R&D) policy rather than innovation policy;
- (h) the limited quality and legitimacy of facilitation.

The points a through d have already been touched upon in some detail above. Below we will further elaborate on points e through h.

Low quality of problem diagnosis and demand articulation

In the privatisation discourse one can find considerable rhetoric about the importance of ‘demand driven’ service delivery. In discussions about this, however, two meanings of ‘demand’ are easily confused (Klerkx et al, 2005). The first meaning is ‘demand’ in the economic or financial sense, which refers to whether or not there is sufficient economic buying power to pay for certain services required, as a condition for creating an interaction between market parties. The second meaning is ‘demand’ in the substantive sense, referring to the interest that clients have in certain services and contents, respectively the questions clients pose. Although policy discourses often suggest that the ‘substantive demand’ of farmers and stakeholders must be the driving force, we regularly see that policy measures are primarily about stimulating ‘economic demand’ (e.g. by means of voucher systems). Practice learns, however, that one cannot assume clarity about substantive demand in cases that there is effective economic demand. In fact, capturing substantive demand is not an easy task.

In a complex multi-stakeholder innovation context the finding of relevant questions and demands is complicated in various ways: (a) there often exist different disciplinary and (conflicting) stakeholder perspectives from which questions and demands can be derived; (b) uncertainties and knowledge gaps are often implicit and concealed in stakeholder interactions, so that ‘demands’ are not (or can not) be formulated explicitly in advance; (c) it is not immediately clear how problems and opportunities (and the questions and demands related to these) that exist at different sub-systems (see e.g. Klein Woolthuis et al, 2005) or systems levels are interrelated, and which have the most potential to leverage change; (d) there inherently is an interaction between ‘demand’ of services, and the ‘supply’ that providers of KIIS services may be able and willing to generate or provide; (e) gaps in understanding may well change in the course of time; and (f) because there exists a range of strategies to address knowledge gaps, ranging from the mobilisation of existing information to engaging in different kinds and types of research. Thus, both raising awareness and articulation of the most relevant ‘demands’ and the translation of these into services is far from straightforward, and requires considerable diagnostic and methodological skill as well as sufficient time and flexibility. Such competencies and time are frequently lacking (see e.g. De Grip & Leeuwis, 2003; Klerkx et al., 2005). Moreover, as soon as different demands become clear, it may eventually require valuable (and therefore political) decisions as to whose demands and questions are being given priority to and why. In

a multi-stakeholder setting such choices can hardly be avoided, but it is an area that knowledge workers are often not very comfortable with (e.g. in view of a wish to claim ‘objectivity’ and ‘neutrality’), and for which they, in most cases, also lack legitimacy. The latter is especially true when governmental bodies and democratic institutions fail to set clear priorities about preferred directions and criteria that scientists can use as starting points for selecting relevant questions and/or for clarifying the pros and cons of alternative options.

In connection with the role of government, one could argue that the notion of ‘demand driven’ is rather problematical in the context of publicly funded service delivery, since nowadays there is usually a friction between the interests of the government and the interests of farmers. Currently the Dutch government focuses on reaching societal goals regarding ecology and the environment, that often contradict at least partly with individual farmers’ immediate economic interests. Thus, one could say that government bodies are currently inclined to especially fund service delivery on issues in which farmers do not have an autonomous interest.

In all, the notion of ‘demand driven’ is too problematical to serve as the dominant guideline for KIIS service providers, even if it remains essential to try and capture stakeholders’ uncertainties and knowledge gaps that hinder progress in innovation trajectories. Demands are to be discovered (and in many cases agreed upon) in a creative learning and negotiation trajectory that includes experimentation, confrontation between different stakeholders, and information from outside (e.g. strategic intelligence, see Smits, 2002 and 2004).

Conventional ways of defining and articulating KIIS supply

As indicated above, articulation of relevant demands and questions requires interaction and confrontation with possibly relevant services by KIIS service providers. As discussed in section 4, the changing insights in innovation processes imply new roles for researchers and communication specialists. In other words, research and extension organisations need to rethink the kinds of services they can deliver and supply to (networks of) societal stakeholder. Although awareness about the need of developing new KIIS services seems to be growing, this has not yet led to a clearly articulated and internalised set of new services that research and extension services can provide. Instead, conventional roles and services (such as on-station research, individual advise, group extension) still seem to dominate the scene, while different kinds of services (joint fact-finding through collaborative research, on-farm research, system diagnosis, opportunity analysis, demand articulation, capacity building, facilitation of learning and negotiation, aligning technology with new social arrangements, process management, brokerage, network building, advocacy, reflexive monitoring, providing strategic intelligence, etc.) remain implicit and underdeveloped as possibly relevant products. At times the (real or perceived) expectations of key clients (who may also think along conventional role divisions) may reproduce this situation.

The continued dominance of ‘knowledge policy’ rather than ‘innovation policy’ Related to the above is that ‘innovation policy’ still tends to be defined as ‘knowledge policy’.

Policy and project documents still are full to bursting with 'knowledge development', 'research and development (R&D) policy', 'knowledge transfer' and 'knowledge dissemination'. Apparently, innovation is still primarily associated with being knowledge driven and/or as somehow having to do primarily with a lack of knowledge. As argued by Smits (2004) it is a misunderstanding to think that innovation depends on developing new knowledge (in this case in the Netherlands), as it has more to do with capitalising on existing knowledge available on a global scale. In addition, it is clear that –from a social learning perspective- the use of such existing knowledge may be prevented by other 'reasons for action'. In many agricultural problem contexts (e.g. mineral management and organic agriculture) lack of technical or other expertise is not a key obstacle to change. Here, the arrival at new patterns of coordinated action (i.e. innovation) is hampered more by troubled relationships, conflict, lack of agreement, absence of well functioning institutions and payment mechanisms and/or lack of coherence and coordination in social networks. Thus, the entry point in many innovation processes should be the changing of social relationships and institutions; while new and existing knowledge and perspectives can still be useful vehicles in this realm, they should not be the central starting point.

Limited quality and legitimacy of facilitation and process management

Although we see that there tends to be more attention for issues such as facilitation and process management, its nature is frequently problematic when looked at from an innovation theory perspective. While innovation processes have a long time horizon and may require overseeing and support of facilitation tasks (see section 4) over a prolonged period, the impression is that facilitation is frequently interpreted as 'developing creative ways of conducting a stand-alone meeting'. Of course, it can make sense to occasionally hire a professional facilitator to ensure that more complex project activities run smoothly and achieve process objectives, but in a long term learning and negotiation process competent facilitation, process leadership and monitoring can be equally (if not more) relevant behind the scenes and in-between official meetings. A related problem is that process leadership must not only be competent and based on understanding of the complexities of innovation, social learning and negotiation, but it must also be regarded as legitimated by the societal stakeholders involved. Especially when tensions are high, a facilitator needs a fair amount of status, credibility, charisma, influence and trustworthiness in order to be successful. Clearly, such qualities are rare, dependent on a specific context, and persons that meet such criteria are unlikely to be employees of KIIS service providers.

A vacuum in 'scaling out' and feedback

So far, most new arrangements tend to focus on the development of new innovations. In most instances we see that applied researchers co-operate with relatively small numbers of selected farmers and/or other stakeholders, supported in some cases by private consultants. There are

few initiatives, which are aimed at connecting with the large majority of farmers (see Gielen & Zaalmink, 2005) and their core intermediaries (private consultants, veterinarians, accountants and magazines). One of the major initiatives -the Mineral Management Liaison Service- was short-lived (see Klerkx et al, 2005; De Grip & Leeuwis, 2003), and only very recently we see new initiatives come to life (e.g. the Horticulture and the Dairy Academy). The overall picture, however, is still that the privatization has led to a substantial widening of the gap between applied research and key intermediaries (Kuiper, 2002). There no longer exist well-established and routine-like linkages between these two entities. This is not only to the detriment of the spreading or 'out scaling' of relevant knowledge and information, but also hampers effective interaction and provision of feedback in the system. According to van der Ploeg (1999) not only research institutes, but also the government has effectively lost its 'eyes and ears' in agrarian communities after the privatisation of the extension service. And consequently, he argues, the government is much less able to formulate well-adapted policies, including policies for research and communicative intervention.

Underdeveloped knowledge stocks

As we know since the path-breaking book by Berger & Luckman (1966) scientific knowledge and socio-technological development co-evolve. In fact, the modernization of agriculture as discussed earlier in this paper is a prime example of this co-evolution. The implication is, of course, that existing knowledge stocks in AKIS predominantly fit in, and privilege, this 'modernisation' type development. As a consequence, the knowledge needed for a more sustainable agriculture appears relatively underdeveloped. One example concerns knowledge on maintaining animal health and curing disease in livestock systems with less control over animal's life circumstances (Bos et al., 2003). This is a problem frequently encountered in projects for designing new types of agricultural developments.

Non-conducive conditions for trans disciplinary science

Since the (sub-)disciplinary divisions within AKIS have also co-evolved with the modernisation of agriculture, contemporary societal problem solving can benefit much from forms cross-disciplinary cooperation and interactive approaches towards innovation and research. Yet, this appears far from simple (Grin et al., 2004): we often see that the members of knowledge institutions (universities, research institutes, etc.) find it difficult to realise this kind of cooperation, and remain – in line with the dominant reward system - to work along disciplinary lines. This relates to, among others, dominant organisational forms, cultural beliefs among scientists and existing reward structures in science. In the organisational sphere, for example, we see that science organisations have come to be separated along disciplinary lines. Researchers are enrolled in and paid by organisational bodies (e.g. faculties, institutes, departments) that represent a particular discipline (e.g. soil science) rather than a societal problem field (e.g. food security). Thus, researchers with diverging disciplinary backgrounds function in distinct organisational

hierarchies, and often also at a different location. Similarly, many academic and professional journals, societies and conferences are characterised by a disciplinary identity as well. As a result, formal and informal contacts between people belonging to different disciplines are far from self-evident. Hence, researchers frequently have very little affinity with what others (can) do. Moreover, the first loyalty of researchers lies frequently with their own disciplinary unit, resulting often in an inclination to reserve maximum resources (e.g. research budgets) for their own unit, rather than dividing them between several units.

In the sphere of reward structures we see that academic status and promotion opportunities commonly depend to a considerable extent on the number and quality of publications that a researcher produces. Getting 'quick' results that are publishable in high status journals, therefore, is imperative if one wants to move ahead with one's career. However, cross-disciplinary (and interactive) cooperation can be a slow and difficult process with uncertain outcomes, and it is not very easy to get cross-disciplinary articles published in high status (often disciplinary) periodicals. Thus, assessment rituals can make researchers weary of engaging in cross-disciplinary and interactive research.

Different language and cultural convictions too may form obstacles to trans disciplinary modes of work. Researchers from the natural, economic and social sciences may hold on to rather different epistemological and methodological beliefs. Hence, tensions can and do emerge easily on whether insights are 'true', 'valid' and 'relevant' or not. Similarly, we see that many scientists are still influenced heavily by linear thinking, whereas others strongly believe in the blessings of interactivity. As a consequence disagreement may arise easily regarding the appropriate role and attitude of researchers in an innovation process. This is especially so since generally accepted and/or applicable methods for coherent cross-disciplinary analysis and synthesis seem to be missing, as do competent and accepted process managers.

With regard to funding, a pervasive characteristic is that the funding of 'research' is often separate from the funding of related activities such as 'extension' or 'innovation'. The implicit message here being that these are somehow completely different spheres of activity, which clearly they cannot be when looked at from our systemic perspective on innovations and innovation processes. The existence of largely disconnected streams of resources can easily reinforce incompatibilities and lack of cooperation and coordination between research and various efforts geared towards societal problem solving. Not surprisingly, then, scientific research often integrates better - in terms of exact questioning and/or research set-up- with previous research than with practical problems and real-life innovation efforts.

Conclusion: contradictory discourses

Although the above analysis is based partially on provisional impressions, there seems to be sufficient reason for anxiety and critical reflection. In essence, we see that the two discourses which have shaped the bringing about of new arrangements (i.e. the discourse of privatisation and that of innovation) do not seem to match well.

It transpires that the idea that applied agricultural knowledge can be treated as a private and/or toll good, that can be exchanged effectively and efficiently through a market for KIIS services, may only be valid in the case that 'proven' and easily adaptable innovations are already available. By this one of the main characteristics of innovation processes, innovation as a learning process (Lundvall, 1992) is not taken into account. In case this (knowledge as toll goods) does not apply, however, the overall impression is that such markets may well complicate the very innovation processes that are necessary to arrive at such 'proven' innovations. This is because commercialisation of service delivery can easily lead to interaction patterns that hinder the flexible cooperation, learning ability, pro-activeness and creativity that is necessary in order to enhance innovation. In conceptual terms, we can say that the notions of 'supply' and 'demand' are in many ways not applicable to innovation processes. In the discourse on commercial delivery of KIIS services, the 'demand' side is mostly associated with users of knowledge (farmers and stakeholders) while the suppliers are thought of as developers (researchers) and transmitters of knowledge (communication workers). The metaphor of supply and demand therefore still carries with it the idea of a clear division of tasks between the three parties. In this sense, it still draws implicitly on a linear model of innovation in which R&D is a dominant element of innovation processes (which is quite paradoxical as the new system was in part introduced as a critique of that model). This is at odds with the idea that innovation processes usually benefit greatly from non-linear and non-exclusive task sharing. In other words: in an innovation process it tends to be rather unclear who 'supplies' and who 'demands' knowledge and information, as successful innovation requires the integration of relevant (but often still implicit) insights and information from several parties. As a consequence the term diffusion is not very relevant in this context. Instead of bringing a package of knowledge from A (the producer) unchanged to B (the user), many innovations occur in this interaction. This means that it is inherently unclear who should be paying to whom in a multi-party innovation process. In stead it is better to speak of a process of 'innofusion' in which innovation and diffusion coincide and actors perform various roles depending on the stage the innovation process is in. In addition, we see that the kinds of services being demanded and supplied (with some exceptions) still resemble those that existed in the EER-tryptich era in that they still focus very much on 'knowledge', respectively that services that would be more in line with an innovation perspective are not articulated sufficiently. All in all there is reason to worry about the capacity of the current knowledge infrastructure (and its relations with users and other actors involved in innovation processes) to effectively support innovation towards sustainable agriculture and multi-functional land-use.

7. Towards a research agenda

A number of research themes regarding new knowledge arrangements can be derived from the above.

(1) Theoretical research on the role of new arrangements in innovation systems

It is important to further conceptualize the idea of new knowledge arrangements, and provide it with a better innovation theoretical grounding. It is important, for example, to develop insight in how elements of new arrangements are linked to innovation systems, to identify and develop systemic failures, systemic instruments, as well as to deepen insight in different kinds, phases and pathways of innovation (Berkhout et al, 2003). In addition, there is a need to clarify the relations between different kinds of knowledge arrangements and the core competences associated with them. On the basis of this, an overall framework for characterizing new arrangements needs to be developed.

With regard to this more fundamental research excellent opportunities for cooperation with researchers from the KSI network are available.

(2) Historical documentation and analysis of the agricultural innovation system

The Dutch agricultural innovation system -in particular the 'EER tryptich'- is internationally known for its contribution to agricultural development. A thorough and systematic historical study of the emergence and functioning of the agricultural innovation system in different periods and in different domains is lacking, and neither has the disintegration of the system been documented thoroughly. Historical comparison with other sectors' innovation systems is not available either. The stimulation of such studies would not only be worthwhile for the sake of historical documentation, but is also likely to produce insights that are relevant in view of the current challenges that the knowledge infrastructure is facing.

This part of the program may build on the work done in the framework of the TIN (Technology in the Netherlands)-20 program, and potentially also on its European follow-up, the TENSIONS program. It is to provide a context for describing and assessing new arrangements.

(3) Systematic inventory and comparison of already existing new arrangements

Although many different types of arrangements emerge (and disappear again) in the knowledge infrastructure, a clear and systematic overview of developments since the 1990s is remarkably absent. An overview of newly emerging arrangements and their characteristics could contribute to transparency of the knowledge infrastructure. The characteristics distin-

guished should fit with the overall framework developed under (1), and hence include variables such as:

- mix of arrangements (see e.g. the types distinguished in section 5);
- level of ambition regarding innovation and/or challenging the existing knowledge infrastructure;
- KIIS (including KIBS) services provided;
- methodological approach.

Doing similar studies in other European countries that are in a similar position would further increase the value of the study.

(4) Ex-post assessment of the contribution of new arrangements to innovation

In addition to making a descriptive overview of new arrangements, it would be important to systematize the lessons learned regarding the new arrangements. These new arrangements can themselves be seen as pilot projects or niches, i.e. as more or less isolated domains in which network building, social learning and negotiation takes place, regarding both the innovation that is worked on, and the new knowledge arrangement itself. Both aspects need to be assessed. Particular attention could be given to:

- factors affecting the continuity of the arrangement;
- key methodological and institutional lessons arrived at in terms of the problematic aspects discussed in section 6;
- inter-subjective assessment of the contribution of arrangements to innovation processes;
- network formation, niche branching, replication, up scaling and out scaling.

It is clear that it will not be possible to study the contribution of arrangements in a very detailed manner and/or against the horizon of a proper baseline since developments are already ongoing. However, it is possible to arrive at valuable inter-subjective assessments by means of e.g. in-depth interviewing and focus group discussions with diverse stakeholders (implementers, clients, funding agencies, competitors, etc.). In some cases additional information may be collected from project documentation and from mostly 'grey' evaluation studies. For some arrangements (e.g. System Innovation programs, the Mineral Management Liaison Service, Farming with a Future, InnovationNetwork, the Novel Protein Food project, the Network Program, Regional Innovation Networks, etc.) more elaborate evaluations exist, even though conducted from different perspectives and lines of questioning (see Grin et al., 2004; De Grip & Leeuwis, 2003; Van Staveren & Grin, forthcoming; Loeber, 2004; De Grip & Leeuwis, 2005; Aarts et al., 2004).

Drawing on this inventory of arrangements (3) and their assessment (4), methodological, praxeological and practical lessons may be drawn. Here, synergy may be sought with prac-

tice-oriented research to be undertaken in the KSI context. More in particular cooperation could be strived for with the Pytheas project in which new participative, systemic instruments are identified, analyzed and/or developed and applied (Smits et al, 2005).

(5) The social shaping of everyday interaction in new knowledge arrangements

In addition to assessing outcomes and drawing methodological lessons (theme 4) it is important to improve our theoretical understanding of the social interactions taking place in the context of new arrangements. In other words, we need to understand better how results are being produced in everyday practice, and why. Therefore it is important to study everyday interaction among actors involved, and see how these are shaped actively by, on the one hand, actors' agency and efforts to create room for manoeuvring, and, on the other, by the drawing upon institutional and structural properties that characterize the knowledge arrangement or the wider innovation system. Thus, the interest here is in developing a better understanding of the articulation between the 'micro' level and phenomena on the level of the 'regime' with regard to the functioning of new knowledge arrangements. In view of the issues discussed in section 6, specific attention may be directed to improving our understanding of:

- patterns and dynamics of 'demand' and 'supply' articulation in trans disciplinary research;
- the relation between funding arrangements and space for learning and experimentation;
- the efficacy of different 'binding elements' in counteracting diverging tendencies in innovation systems;
- the espoused (innovation) theory and the 'theory in use' within the arrangement (Argyris & Schön, 1974);
- the nature and significance of barriers impeding the transition from mode 1 to mode 2 science;
- internal and external factors affecting learning and innovation;
- the articulation between 'top-down' and 'bottom-up' influences in innovation trajectories.

(6) Methodology development for reflexive innovation process monitoring

We currently witness considerable public investment in new knowledge arrangements and both policy makers and knowledge workers are under increasing pressure to show 'return on investment'. In addition it is increasingly recognised that forms of monitoring are necessary to increase reflexivity during an innovation trajectory so that the process can be re-directed if necessary (Forester, 1999; Grin et al., 2004). However, a feasible monitoring and evaluation approach that is suitable for both (a) assessing the contribution of different knowledge arrangements to innovations, and (b) enhancing the learning capacity within specific innovation trajectories is lacking (Leeuwis et al, forthcoming).

Conventional 'effect' evaluation faces fundamental problems in the case of innovation-oriented programs since one can not pre-define usefully substantive effects. In innovation trajectories problem definitions, search directions, solutions and routes are likely to (respectively

must be allowed to) change. Moreover, innovations consist of many different social and technical components that can not be usefully defined in advance and are partly invisible and/or difficult to recognise (Wiskerke & Van der Ploeg, 2004). In addition, the kinds of innovation processes at hand take place in society (and often during a prolonged period) so that it is notoriously difficult (if not impossible) to isolate the influence and contribution of a particular program. Finally, it is recognised increasingly that the fact that many initiatives for innovation eventually 'fail' is a normal state of affairs in view of the evolutionary character of innovation dynamics (Bijker et al., 1987; Rotmans et al., 2001), respectively that a certain redundancy of competing initiatives is needed to arrive at a 'fitting' combination of old and new social and technical arrangements. These characteristics pose fundamental difficulties for assessing the 'effectiveness' of change oriented programs. In addition, conventional approaches to M&E have been widely criticised for their limited contribution to learning from and adaptation of ongoing change processes, and for their insensitiveness to taking on board relevant stakeholder criteria and objectives and to capturing emergent (including unintended) dynamics (Uphoff, 1989; Estrella et al., 2000; Guijt, 1999). In this light, there is widespread agreement that more process-oriented monitoring approaches need to be developed which provide useful feedback to the stakeholders in the innovation process as well as to scientists, policy makers and facilitators who may be involved. In other words, an approach that contributes to the 'reflexivity' of the process (Weterings & Grin, 2005).

The methodology will have to be developed in an interactive manner, not at least since it is likely that it needs to be implemented in part by participants of innovation trajectories. Moreover, it will have to be tested and applied, for example to study and compare the contribution of current knowledge arrangements in ongoing innovation trajectories (thus contributing to theme 2). Finally, it is important to evaluate the added value of the monitoring approach to the information of policy makers and participants in innovation trajectories.

(7) Coping strategies and self-organization in the knowledge infrastructure

As elaborated above, the various actors in the knowledge infrastructure are confronted with numerous challenges. However, they must not be regarded as passive agents who await further development of knowledge arrangements by governments and/or knowledge providers. They are likely to devise strategies to deal with challenges confronted, find new ways and networks for accessing knowledge, and devise informal 'new knowledge arrangements' that remain hidden for policy makers and managers in the knowledge infrastructure. Increased insight about such informal practices, strategies and arrangements may provide crucial information for improving the functioning of the knowledge infrastructure. In particular it would be important to study coping strategies and forms of self-organization in connection with actors who seem to be least formally connected to the current knowledge infrastructure: i.e. large categories of farmers and conventional intermediaries (i.e. private extension, con-

sultants, veterinarians and accountants). In addition, it would be informative to gain similar insights from research staff and process facilitators.

(8) Development and evaluation of methodological approaches and pathways for out scaling, up scaling and multi-level learning

The idea that innovations consist of 'hardware', 'orgware' and 'software' in a network of inter-dependent actors implies that the original conceptualizations of 'diffusion' and 'dissemination' (seen as the transfer of knowledge and technology to individuals) have become largely obsolete (see also comment on innofusion). Nevertheless, the question of how a successful innovation in a specific (experimental or pilot) context may spread (or not) and how such spreading might be stimulated is still highly relevant as many seemingly promising innovations fail to become widely utilised. It is increasingly clear, that one cannot simply spread the 'hardware' and 'orgware' components of an innovation, since these need to be contextually re-aligned. In order to achieve this, one needs to at least partially 'repeat' the learning process that led to their design and to the creation conducive 'software'. A process that well may lead to adaptation of the original design in new contexts. Another insight is that a pre-condition to such 'spreading' (or 'out scaling') to new contexts is the 'up scaling' of the innovation in the wider institutional and governance context (Röling & Van de Fliert, 1994; Van Schoubroeck, 1999; Moriarty et al., 2005). That is, chain parties, ministries and interest groups (who are often part of the existing socio-technical regime) must effectively support (or not pose obstacles to) further 'out scaling' efforts. In practice, this implies that 'up scaling' requires attention from the start of an innovation trajectory; not only to create support but also to be able to capture and integrate perspectives, obstacles and windows of opportunity at higher hierarchical levels. The linking of micro, meso and macro levels, however, is far from easy.

From a learning theory perspective, we know that 'experiential' forms of learning (Kolb, 1984) are likely to be most 'powerful' in a societal innovation context. It appears that conclusions that people draw themselves on the basis of their own experiences tend to have a greater impact than insights that are formulated by others on the basis of experiences that learners can not identify with. Although it is clear that such experiential forms of learning (also referred to as 'learning by doing' or 'discovery learning') may be of relevance in enhancing learning in the context of out scaling, up scaling and multi-level learning, there is still a lack of viable methods and tools available for this (Kuiper et al, 2004). This is especially so in the sphere of up scaling, where the challenge is to develop learning experiences and curricula that connect different societal levels (Moriarty et al, 2005; Van Staveren & Grin, 2005). Therefore, the development, evaluation and comparison of various methodological strategies or tools for discovery learning (e.g. pilots, condensed learning trajectories, 'black boxing' (Schot et al., 1994), different forms of modelling, visual appraisal techniques, etc.) would be an interesting area of study, which could be implemented in an action research mode in TransForum's Scientific Projects. Other (e.g. non learning-based) strategies could be considered here as well.

(9) Assessing the contribution of TransForum to innovation and institutional change

TransForum itself also qualifies as a 'new knowledge arrangement' with a mandate to contribute to innovation and transition, with specific attention to realizing a transition in the knowledge infrastructure from mode 1 to mode 2. TransForum is contractually obliged to conduct monitoring and evaluation according to the standards of its main funding agency, but as outlined under theme 3, such standards may not be very appropriate for capturing the essence of what TransForum tries to achieve. In a way the attempts of TransForum to stimulate the transition to mode 2 is assessed by criteria and has to be implemented with researchers acting in mode 1. To overcome this structural and cultural problem maybe is one of the greatest challenges TransForum has to face. It is therefore pertinent that TransForum applies a reflexive monitoring strategy to some of its own activities, and in particular to its efforts to renew the knowledge infrastructure. An important condition to make such a learning process effective is the availability of researchers and practitioners that are able to change their mindset towards mode 2 while at the same time they have to function in a mode 1 environment.

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Knowledge Management in International Networks

A position paper for TransForum

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Summary

Networks and knowledge are intimately connected. Networks are believed to be innovative because of the smooth transfer, combination and creation of knowledge that can take place in them. Interestingly however, knowledge management research has hardly studied knowledge management techniques in networks. This despite the fact that knowledge does not flow through a network automatically. Knowledge flows more easily within a firm than across its boundaries. In international networks the problems connected to knowledge flows are even bigger: knowledge has to cross boundaries of time, space and culture.

To create innovative international networks it is therefore imperative to implement adequate knowledge management systems and processes. They should be aimed at alleviating the barriers to the flow of knowledge that exist in networks. Without them it is unlikely that a sustainable competitive network can exist.

As Dutch agriculture is increasingly setting up international networks, knowledge management is important for the Dutch agrifood. Relevant questions are:

- How can knowledge from diverse locations across the world flow to Dutch companies for them to build up a competitive advantage?
- How should Dutch agricultural firms exploit their knowledge effectively in their international networks?
- Is it possible to create knowledge in The Netherlands without having primary production within the country (as the idea of Nederland Kennisland suggests)?
- Can effective knowledge management in international networks replace the proximity effect (knowledge flows faster within a region than across regions)?

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This paper reviews the existing literature on knowledge management in networks. It proposes a framework to study knowledge management, which assumes that the effectiveness of different types of knowledge management depends on the type of network and the nature of knowledge in that network. Avenues for further research in this area are sketched.

Introduction

Many networks are successful because they are geographically concentrated (Porter, 1990). Geographical concentration enhances the speed with which knowledge and innovation spread through a network. When companies want to start up international networks, as for example Dutch pig breeders do, or when local networks start to internationalize, as the Dutch horticulture business does, they face a challenge: how to ensure that knowledge flows effectively through international networks? When this question is not answered, it will be hard for those companies to exploit the knowledge present in their network and to gain access to new knowledge acquired by their foreign partners. For continuous innovation in an international network, knowledge needs to flow from one partner to the next. The idea of an economy based on creation and exploitation of knowledge in an international network with the core in The Netherlands, will remain elusive when knowledge management in a network can not be realized.

Knowledge management in networks is however a topic that has not received much attention in research. Even though a number of authors see networks as the organizational form of the knowledge economy (De Man, 2004), the managerial aspect of how to create, share, access and leverage knowledge in a multi-company network is hardly understood.

This paper reviews the literature related to knowledge management in networks and proposes an initial framework to study this topic. It starts by reviewing the literature on knowledge management in alliances. As networks are sets of alliances between companies, this literature is relevant for networks as well. The review will show that knowledge management in alliances is relatively well understood. A review of the literature on knowledge management in networks shows that networks face some additional problems with knowledge management. The literature also proposes some solutions, but the validity of those solutions has not been tested. To encourage further research, a framework for studying knowledge management in networks is proposed. Finally implications for people, planet and profit are defined, in relation to the Dutch agrifood business.

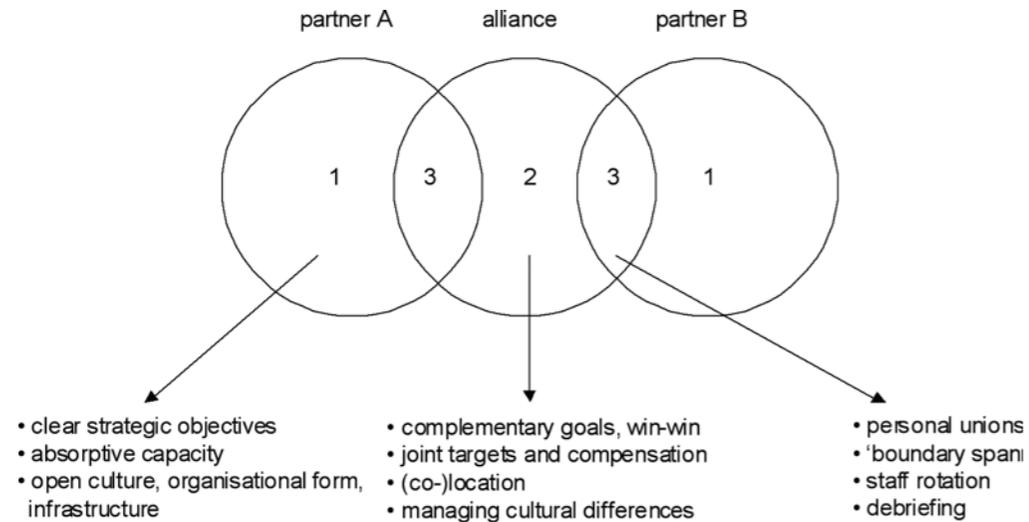
Knowledge management in bilateral alliances

Regarding the role of knowledge in networks, the literature has mainly focused on knowledge management in bilateral alliances. As alliances are the building blocks of networks (De Man, 2004), no account of knowledge management in networks is complete without an understanding of how knowledge may be managed in bilateral alliances. A first prerequisite for effective knowledge management in networks is effective alliance knowledge management. Because alliances are the building blocks of networks, effective knowledge on a network level cannot be realized without proper knowledge management on an alliance level. Adequate knowledge management for bilateral alliances requires attention for (Figure 1):

- Internal company knowledge management
- Partnership knowledge management
- Knowledge transfer management (between partners and the partnership).

Regarding internal company knowledge management (indicated by the number 1 in Figure 1), all learning starts with clear objectives about what is to be learned. Without such an objective alliances will remain collections of collaborative structures, lacking all coherence. Especially companies who wish to experiment must set clear goals as to what they want to learn from their experiments. In order to learn, companies must be able to absorb outside knowledge (absorptive capacity; Cohen and Levinthal, 1990). This is possible only if they have already acquired some basic knowledge about the topic at hand. Then will they be able to profit from the knowledge their partnerships accumulate around that topic. Knowledge management also requires open structures and systems, and an open company culture. Technological and cultural barriers between companies may hamper the transfer of knowledge across organizational boundaries.

Partnership knowledge management is the second element in alliance knowledge management (indicated by the number 2 in Figure 1). If the participants to a partnership have complementary objectives, knowledge transfer will be relatively easy. On the other hand, competitors will find it difficult, since they don't usually want their competitors to gain knowledge and information about their business. A partial solution to this dilemma is to set up the partnership as an independent company and staffing it with a large proportion of externally recruited employees. Then the chances of information leaking to competitors are minimized.



Source: De Man, Koene and Rietkerken (2001)

Figure 1: Knowledge management tools for partnerships

Knowledge transfer in a partnership will be more successful if the partnership's staff is rewarded on the basis of the partnership's success instead of on that of its parent companies. Joint targets and compensation practices are desirable. The partnership's location is an interesting issue as well. Knowledge transfer runs best when people are co-located (that is, work in the same building). On the other hand: setting up a partnership in a separate location means that the partners' access to knowledge developed in the partnership diminishes. Then there are the cultural differences between the partners. Culturally homogenous partnerships have been shown to be more successful than partnerships between companies from different countries (Parkhe, 1991). Managing cultural differences, therefore, is important. The partnership governance structure is another element in knowledge management (Heiman and Nickerson, 2000). Especially if there is insecurity concerning the outcome of the partnership and the distribution of costs and revenues between the respective partners, these partners will choose complex governance structures such as joint ventures. They would not necessarily have to do so, though, for combinations of complex knowledge management techniques with relatively simple governance structures (licenses, contracts) are sometimes just as effective.

The transfer of knowledge from partners to their partnership and vice versa is another challenge (indicated by the number 3 in Figure 1). To facilitate such knowledge transfer processes several techniques are available (Inkpen, 1998; Lane, Salk and Lyles, 2001; Lyles and Salk, 1996):

- Personal unions: managers working in an alliance also work in one of the partners' organizations;
- Boundary spanners: specially appointed staff with the task to transfer knowledge back and forth between the partners and their partnership, as well as ensure that no knowledge spills over;
- Staff rotation: by regularly rotating the managers assigned to the partnership, their knowledge is channelled back into the parent organizations;
- Debriefing: if the participants' staff assigned to the partnership are properly debriefed (in writing or orally), partnership knowledge is shared with the parent organization.

This brief overview of the literature on knowledge management in alliances shows that there is an understanding of the problems with alliance knowledge management and possible mechanisms to alleviate those problems. Large-scale empirical research exists that has tested the theories developed in this area.

Knowledge management in networks: a framework

Moving the analysis up one level from alliances to networks shows a more complex picture. Fewer studies can be found that look at knowledge management in networks. This despite the fact that much work has been done on theoretical aspects related to knowledge and innovation in networks. Few of the theoretical studies however present tools for managers to use.

The flow of knowledge in networks has received much theoretical and empirical attention. Theoretically the social capital view (Coleman, 1990) and the structural holes view (Burt, 1992) have provided conceptual underpinnings for the idea that company positions in networks determine their ability to profit from knowledge flows. The social capital view states that close and redundant or repeated relationships create longevity and a feeling of trust among partners (Gulati, 1995) which are necessary for knowledge to flow smoothly from one company to the next. The structural holes view however points out the risk of overembeddedness (Lemmens, 2003): having long-term ties with the same partners reduces the chance that partners are exposed to new stimuli so that knowledge transfer and accompanying learning diminishes over time. In this view it is better to occupy positions between different, unconnected companies so that a diversity of knowledge flows to the company is ensured. In the social capital view rents accrue to the group and rules in the group determine the rents for each individual firm, whereas in the structural holes view rent accrues to the firm bridging a structural hole between two unconnected companies (Kogut, 2000).

These conceptual views have given rise to some empirical studies into networks, knowledge and innovation (e.g. Gulati, 1999; Powell, Koput and Smith-Doerr, 1996; Rowley, Behrens and Krackhardt, 2000; McEvily and Zaheer, 1999; Uzzi, 1997; Walker, Kogut, Shan, 1997). These studies show that the optimal number of alliances, the optimal network location of a firm and the optimal density of alliance networks depend on specific circumstances. For example, having many alliances in combination with dense networks (with all partners connected to each other) does not raise innovativeness (Rowley, Behrens and Krackhardt, 2000). The number of studies into this topic is limited and as a consequence, it is impossible to draw any definite conclusions. But the studies that have been carried out show that the optimal alliance network depends on the specific context of the organization.

These theories and empirical studies assume knowledge and information flows between firms. Usually they infer knowledge sharing, and transfer has taken place from an increase in patenting activity by the firms involved. The micro-level mechanisms that underpin such knowledge exchange are not studied. But the question as to how knowledge flows from one firm to another and whether companies consciously manage knowledge flows in networks is relevant. Almeida et al. (2002) for example show that knowledge flows much more easily within one company than across the boundaries of companies. If knowledge flows across boundaries of firms have a profound effect on the learning of firms, as empirical studies indicate, then the question becomes relevant what mechanisms companies use to overcome the obstacles to interfirm knowledge exchange. Knowledge does not flow automatically between companies in a network. How do companies manage knowledge in networks? How do they ensure the right knowledge flows to the right network partner? What is left to chance and which knowledge is consciously transferred?

Considering the attention for networks in theory and large scale academic research, the number of publications on knowledge management in networks is small. Work in the area has mainly been limited to the role of IT support in knowledge management in networks (Carlsson, 2003; Olin et al., 1999; Van Baalen et al., 2005). Related literature on virtual collaboration (e.g. Markus et al., 2000; Rasters, 2004) and communities of practice focus mainly on online settings of collaboration between individuals, not organizations, and is less applicable to non-Internet forms of collaboration. There is some attention for the role of core firms or network orchestrators in a network and their knowledge position. Brusoni et al. (2001) and Brown et al. (2002) find that central companies in a network need to have knowledge in excess of what they need for what they produce, in order to be able to coordinate networks. These contributions are relevant, but as they focus on one aspect of knowledge management in networks an integral view of the topic is still lacking. Knowledge accumulation in this area does not occur.

The closest to defining an overarching framework to study knowledge management in networks were Dyer and Nobeoka (2000). Their detailed analysis of knowledge sharing in the Toyota network centers on problems specific to knowledge management in networks and their solutions (Table 1 summarizes their approach). It is based on the idea that networks face three specific challenges regarding knowledge management. The first challenge is motivating the partners to share knowledge. This problem has been identified by other authors on knowledge management and collaboration as well. The extra complication for interorganizational networks is that in networks pay-offs for contributing to networks may be indirect and unclear. Partners need a long-term perspective to see the real value of collaboration materialize. In another study on Toyota, Dyer (2000) compares the performance of the network approach Toyota uses with suppliers, with the results of the low cost procurement approach of American car manufacturers. American car manufacturers may gain lower prices in the short run, but in the longer run the performance of the Toyota network is better because it provides an incentive to suppliers to continually invest for Toyota.

The problem of motivation can be solved by showing clear value to participants, by creating a network identity which leads companies to take the longer term view on collaboration and by implementing correct rules of ownership and value appropriation. By restructuring the pay of function (Cabrera and Cabrera, 2002) in this way, companies should be motivated to contribute to the network.

The second challenge to knowledge management in networks is the increased opportunity for free-riding behaviour in a network. The larger the group of partners the easier it becomes for companies to profit from the value the network creates without making a comparable contribution to the network. Toyota solves the free-riding problem by explicitly agreeing companies are to share knowledge with the network and by the fact that Toyota as a client can unilaterally impose a sanction on a free-riding partner by ending the supply relationship.

The third challenge is to realize efficient knowledge transfer in a multi-partner setting. When substantial numbers of partners are involved in a network it may take a long time before knowledge required by one of the partners actually reaches that partner. Lowering the search costs connected to finding the right company and person in a network is a problem that must be solved in order for a viable knowledge sharing network to exist. Toyota's solution to this problem is to create as many possibilities for people to meet each other as possible. By creating strong ties (Granovetter, 1973; Brass et al., 1998) between companies and multiple processes for people to meet (events, meetings and associations), structural holes are closed.

Table 1: Knowledge management problems in the Toyota network and their solutions

<i>Problem</i>	<i>Solution type</i>	<i>Micro-level mechanism in the Toyota network</i>
Motivate to share knowledge	Show clear value	Subsidize early stages of collaboration
	Create network identity so suppliers identify with network success	Supplier association Consulting teams Voluntary learning teams Interfirm employee transfer
	Make rules for knowledge protection and value appropriation	Proprietary knowledge about the production process does not exist Supplier can appropriate 100% of the value in the short run, but will share with Toyota over time.
Prevent free-riding	Sanctions	Toyota is major client of partners
	Agreement to share knowledge	Knowledge sharing mentioned in written agreements
Efficient knowledge transfer in multi-partner setting, lower search cost	Multiple processes, strong ties, close structural holes	Different types of meetings, teams, associations enable transfer of both tacit and explicit knowledge. Firms can choose the most efficient route for knowledge transfer Knowledge sharing does not rely on Toyota's facilitation

Source: Compiled by the author, based on Dyer and Nobeoka (2000)

Dyer and Nobeoka's (2000) framework highlights the micro-level mechanisms companies implement to stimulate knowledge-sharing. The effort and investment required to attain a smooth flow of knowledge are substantial. A large number of people are involved and a variety of mechanisms are in place to ensure knowledge from one partner in the network ends up at the right place with another partner. This underlines that knowledge does not flow through a network automatically.

Network type and knowledge management

Whereas the analysis by Dyer and Nobeoka (2000) clearly shows that networks have some additional requirements for knowledge transfer to be effective, there are however a few limits to their analysis. In terms of network type, they only study a supply network, with long-term relationships between the partners, within one cultural setting, with limited competition between partners and a high degree of centralization. Therefore their case only represents a small set of all types of networks. The fact that their theory is based on the Toyota-case means that their conclusions may be idiosyncratic. Whether their analysis is also applicable to other sectors needs to be researched. Will for example Dutch horticulture, that has no powerful central player, face similar problems like the Toyota network and will similar solutions be effective? In addition the horticulture network operates internationally and consists of many direct competitors. Both these elements may have an impact on knowledge management in networks.

The literature points to some characteristics of networks that may influence the effectiveness of knowledge management:

- Aim of the network (De Man, 2004). Whether a network aims to innovate, set a standard or save costs and corner markets will be relevant for knowledge management. The type of knowledge that needs to be managed may differ depending on the network aim.
- Stable or dynamic network (Miles and Snow, 1992). Some networks, like the Toyota network, are stable. The same partners collaborate in them for a longer period of time. Because long-term relationships imply that partners get to know each other intimately, knowledge exchange may go faster and become more effective over time. Moreover, long-term relations may provide an incentive to exchange knowledge because companies may not want to damage friendly relationships with other companies. Dynamic networks are changing partners rapidly. New partners enter, existing partners leave. Biotech networks and networks around Internet technology are examples of dynamic networks. Fast changes make it more difficult for people to get to know each other and to trust each other. This may inhibit knowledge exchange. On the other hand, more new knowledge may enter those networks, thereby avoiding myopia.
- Mono vs. intercultural networks (Parkhe, 1991). Knowledge is exchanged more easily within similar cultural settings. Language, habits and informal institutions differ between countries (Hofstede, 2001; Trompenaars and Hampden-Turner, 1997). Orientations towards power, time, and hierarchy may impact the effectiveness of network tools. A solution to a problem with knowledge management may work well in one culture, but may be counterproductive in another culture. Networks consisting of partners from diverse countries may therefore find it more difficult to manage knowledge than networks consisting of partners with a similar

cultural background.

- The composition of the network may be relevant as well. The type of partners (e.g. vertical, horizontal, competitors or non-competitors) may impact knowledge management, if only because partners from different backgrounds may not have the absorptive capacity to digest each other's knowledge. The presence of competitors in a network will play a role as well. In this case, companies may be reticent to share knowledge when they run the risk of knowledge spill-over or fear that knowledge they contribute to the network may be used against them in the market place at a later stage.
- Centralization: the presence of a strong leader guiding knowledge flows may be a condition sine qua non for the Toyota network. Whether networks without central leaders face additional problems in knowledge management is therefore a relevant question to research. Egalitarian networks exist and may be competitive, but whether their competitiveness is rooted in some form of knowledge management has not been studied.

Whether the solutions as mentioned by Dyer and Nobeoka will work in other network types, therefore remains to be seen. In other network types, different knowledge management problems may exist. In addition, the solutions proposed by Dyer and Nobeoka may be more or less effective depending on the type of network.

Nature of knowledge

A second element Dyer and Nobeoka have not studied in-depth is the type of knowledge exchanged. The Toyota case focuses on tacit and explicit knowledge, whereas other dimensions of knowledge (Alavi and Leidner, 2001) have not been studied. Specifically the question whether knowledge is perceived as core to a firm's competitive advantage or as non-core knowledge may be relevant for the ease with which companies will share their knowledge.

Of course the tacit dimension of knowledge is relevant. Tacit and explicit knowledge can be used in a mutually dependent way. "The inextricable linkage of tacit and explicit knowledge suggests that only individuals with a requisite level of shared knowledge can truly exchange knowledge: if tacit knowledge is necessary to the understanding of explicit knowledge, then in order for individual B to understand individual A's knowledge, there must be some overlap in their underlying knowledge bases." (Alavi and Leidner, 2001: 112)

The explicit dimension of knowledge is articulated, codified, and communicated in symbolic form and/or natural language (Alavi and Leidner, 2001). When the perspective on knowledge management is more oriented towards explicit knowledge as of more value towards an organization, then knowledge management should focus on building and managing knowledge stocks. In that sense knowledge is an object to be stored and manipulated.

The tacit dimension of knowledge is oriented towards the knowledge that is embedded in action, experience, and involvement in a specific context (Alavi and Leidner, 2001). When the perspective of knowledge management is more oriented towards this cognitive knowledge perspective than we can view knowledge for instance as a state of mind which involves enhancing an individual's learning and understanding through the provision of information.

A second characteristic of knowledge that is highly relevant for knowledge management is whether knowledge is perceived to be in the core of company's competitive advantage or whether it is peripheral, non-core (De Man, Koene and Rietkerken, 2001). This dimension of knowledge is relevant because companies will be hesitant to share core knowledge. There is danger attached to sharing knowledge that is fundamental to a company's competitive advantage. Companies may therefore create barriers to knowledge exchange. For example, instructions may be given to personnel not to share certain knowledge or a gatekeeper may be appointed who determines which documents are to be shared with network partners. The latter may severely slow down the circulation of knowledge in a network.

Non-core knowledge on the other hand may give more scope for collaboration. Companies may estimate that cost can be saved in developing or sharing non-core knowledge without any danger being related to that. For this reason such knowledge may flow faster through networks. Knowledge creation in non-core issues may go faster as well. Research in non-core knowledge may be perceived as being less problematic than in core knowledge areas.

Just like the type of network may come with different knowledge management problems and may impact the effectiveness of knowledge management solutions, different knowledge types have the same effect. For example, tacit knowledge may require different tools and processes than explicit knowledge.

Framework for knowledge management in networks: a research agenda

Combining the insights from the Toyota case with the theoretical considerations discussed above, Figure 2 shows a framework for the study of knowledge management processes in networks. The horizontal axis follows the basic scheme defined by Dyer and Nobeoka. Managers may consciously apply tools and processes to alleviate problems with knowledge management in networks. This will stimulate the transfer, integration and development of knowledge, which in turn leads to an increased innovativeness of the network in question.

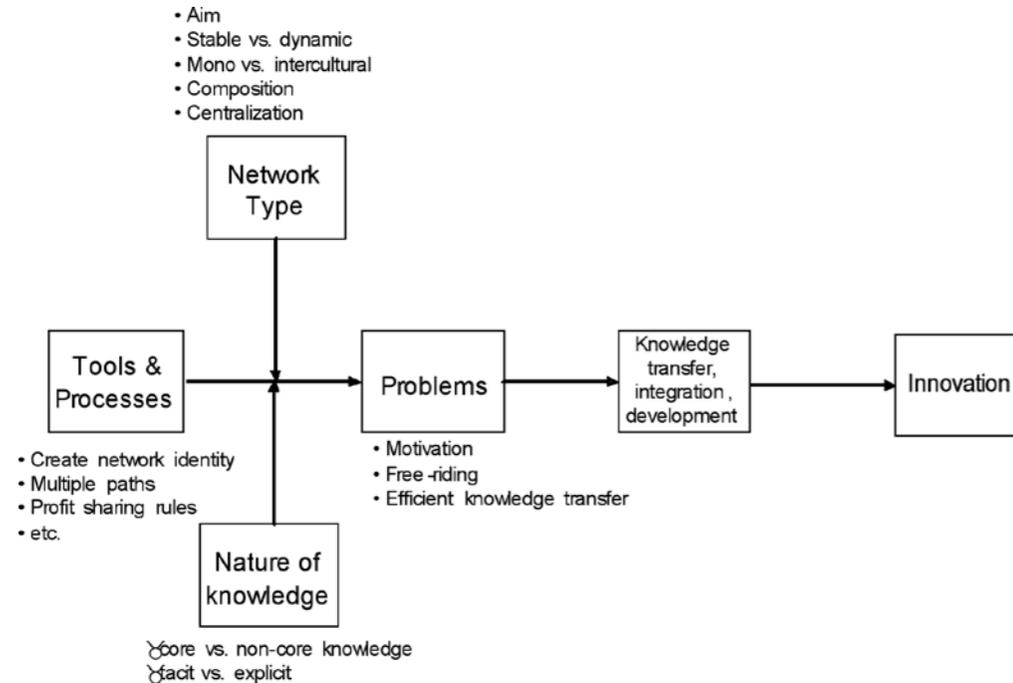


Figure 2: A conceptual framework to study knowledge management in networks

However, there are two intervening variables. Both different network types and differences in the nature of knowledge may:

- Affect the effectiveness of tools and processes in a particular network. The effectiveness of tools may depend on the specific characteristics of the network and knowledge in that network. If this is true this implies that companies need to tailor their knowledge management process to their specific network, rather than using a generic, 'one size fits all' approach.
- Be associated with new problems in the management of knowledge in networks. The problems of the Toyota network may or may not occur in other networks. Other networks may face different problems than Toyota.
- Require new tools and processes to managing knowledge in networks. Other tools and processes than those employed by Toyota may be used in networks. In a case study into a network around the German retailer METRO, De Man and Graczewski (2005) found some examples of this. In this network the problem of efficiency of knowledge transfer was partly solved by creating a website listing partner competencies.

A research agenda for knowledge management in networks follows logically from this framework:

- Do the problems identified in the Toyota network exist in other networks as well and/or can other problems be identified?
- Are there any other tools and processes companies implement to overcome the challenges of network knowledge management?
- How does the effectiveness of tools and processes differ per type of network and type of knowledge?

An additional question relates to the dynamics of knowledge management in networks. How do knowledge management processes change over time? In the Dutch horticulture network in the Westland these processes have changed considerably over time. Starting out informally with growers visiting each other's production sites, these groups became institutionalized, broadened their scope to include not just knowledge on growing but on management as well. In a later phase they evolved into producer associations, for the more advanced companies, and crop committees for the less advanced organizations. Knowledge management mechanisms therefore are not stable over time, but adapt to changing circumstances. The ins and outs of these dynamics are an interesting research question.

To answer these case studies multiple comparative case studies are the first step. They can be used to identify other problems and tools and processes around knowledge management in a networked context. Next large-scale empirical research may test hypotheses about the relationship between network type, knowledge type and effective knowledge management.

Implications for people, planet, profit

What are the implications of this analysis for people, planet and profit in a context of transition?

The previous analysis and framework has some implications for people, planet and profit. On the level of people, the analysis directs attention to the conditions which stimulate and inhibit people to exchange knowledge among each other. The presence of sanctions and rewards on knowledge sharing has an affect on the individual and the satisfaction he feels in his job. The chance to learn continuously in an effective knowledge sharing network is important to individuals not just for their own development, but also because membership of such a network increases employability. In a knowledge economy in which knowledge ages rapidly, it is important for people to be on the forefront of knowledge to remain employable. Second, the complexity of learning in a network context is stressed. When entering into a network an individual may be awed by the possibilities or frustrated by the limits to knowledge sharing. To get a grip on the new reality of working in a knowledge and network economy, structured knowl-

edge management processes may be very helpful. Third, the analysis points to the necessity to help people adapt to a new economic environment. As the flow of knowledge is so important in networks, the innate reaction of many people not to share knowledge with other companies may have to be changed into an innate reaction to share, depending on company interest. It is not sufficient to communicate this to individuals in a network: it requires tools and processes to empower and enable individuals to share knowledge as well. Simply stating they must share knowledge is not enough: the Toyota case shows that a network must be designed to support knowledge sharing on the level of the individual.

As to planet, the implications of this paper are only indirect. Knowledge aimed at sustainable production may spread faster throughout networks with a thorough understanding of knowledge management in networks. The increasing demand to produce in an environmentally sustainable way implies that organizations furthering sustainable production may look at optimizing the flow of knowledge in networks as a way to achieve their ends. Merely introducing knowledge about sustainability at isolated places in a network does not help much.

The most important contribution of this paper is to the profit aspect. As outlined in the opening section, knowledge has become instrumental in gaining a competitive advantage. The faster knowledge is developed, integrated and exchanged the more a network will gain a competitive advantage over other networks and the more the constituent partners will gain. Especially when networks are set up on an international scale and the pressure-cooker effect of proximity is lost, the demands on explicit knowledge management techniques will only increase.

For Dutch agriculture in particular the next questions are relevant:

- How can knowledge from diverse locations across the world flow to Dutch companies for them to build up a competitive advantage?
- How should Dutch agricultural firms exploit their knowledge effectively in their international networks?
- Is it possible to create knowledge in The Netherlands without having primary production within the country (as the idea of Nederland Kennisland suggests)?
- Can effective knowledge management in international networks replace the proximity effect (knowledge flows faster within a region than across regions)?

These questions need to be answered for Dutch agrifood sectors to make the transition towards a knowledge economy.

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