

Seeds of Transition

Essays on novelty production,
niches and regimes in agriculture

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1 On Regimes, Novelties, Niches and Co-Production

*Jan Douwe van der Ploeg, Johan Bouma, Arie Rip,
Frits H.J. Rijkenberg, Flaminia Ventura and
Johannes S.C. Wiskerke*

At specific conjunctures in time, the need arises to introduce new key-terms to single out and highlight phenomena that – until then – have lain hidden in the obviousness of everyday life. Novelty production is, we believe, such a key-term. Derived from the rich tradition of technology studies, it is a new and probably somewhat unfamiliar concept in agriculture, in the world of farmers, fields and agricultural engineers. Its use may even cause some unease, since it refers to longstanding practices that hardly seem to need any further discussion, let alone any new terms. However, we believe novelty production to be a concept that, together with the associated notions of socio-technical regimes and strategic niches, might help find new ways out of the many-faceted crises that agriculture is currently facing.

Novelties and novelty production

What then is a *novelty*? A novelty is a modification of, and sometimes a break with, existing routines. It is, in a way, a deviation. A novelty might emerge and function as a new insight into an existing practice or might consist of a new practice. Mostly a novelty is a new way of doing and thinking – a new mode that carries the potential to do better, to be superior to existing routines. Novelties can be seen then as *seeds of transition*. At the same time, though, we should stress that a novelty is often perceived as something different, as a potential critique of current performances. When novelties emerge, especially in the beginning, they are sometimes seen as ‘monstrosities’.

The metaphor of seeds of transition is a useful one, since it helps to clarify, right from the beginning, three essential elements. First, novelties need *time* – just as seeds require cultivation and nourishment to germinate, grow, flower and set fruit. They follow a specific unfolding through time before the final outcome (their ‘usefulness’) can be assessed. Equally novelties require time to show whether or not the entailed (or assumed) promises really do materialise. Secondly, seeds require a particular ordering of space, or more generally: a particular organisation of *context*. Sowing seeds on rock bed or in a desert is useless. One needs a well-

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prepared seed-bed, a well organised distribution of water, proper crop protection, and so on. Translated to the level of novelties, this implies that one change in existing routines often implies a second one and then a third and fourth, etc. The first improvement spurs the second one, because it both requires and informs it. That is, a novelty seldom remains isolated; a novelty will result in a wider *programme* of interrelated, and mutually reinforcing novelties. Thirdly, the inherent *insecurity* needs to be stressed. Just as harvests may fail, novelties might turn out to be failures as well. Novelties are related to *expectations*. It is, however, far from evident whether the eventual outcomes will match the initial expectations. Thus a novelty is, to echo Rip and Kemp (1998), 'a new configuration that *promises* to work'.

Continuing the same analogy, we could equate the notion of novelty to a mutation through which a single new variety of seed arises, through mutation in just one seed. That single seed falls on the ground, germinates, the plant grows, flowers, sets seed and shows characteristics that other non-mutated seeds do not have. That is a first, one-off, different outcome. If this first outcome is 'recognised' by the environment as being advantageous, more seed with this new characteristic might be produced. This would then be a second-level or 'general acceptance level' outcome: a general recognition in the context that this represents a beneficial change. Conversely, the 'first' outcome might go unnoticed (which is the most common scenario). Then the novelty remains a 'hidden one' – it might even be nipped in the bud.

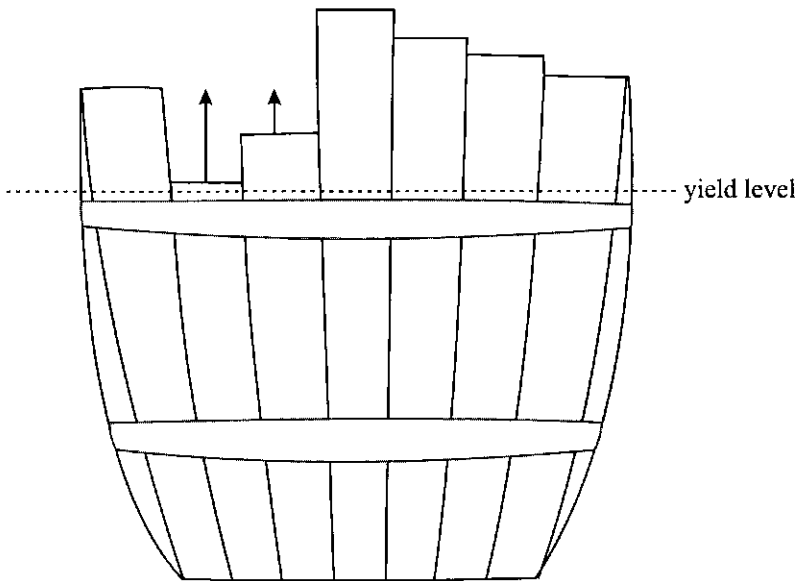
The history of agriculture is a history of novelty production. Over the centuries farmers have introduced, on purpose or unintentionally, small changes in the process of production, resulting in a steady but ongoing increase in yields. This process has been amply documented by, amongst others, Slicher van Bath 1960; Boserup 1965; de Wit and van Heemst 1976; de Wit 1983; Richards 1985; Bieleman 1987; and Osti 1991.

Analytically speaking it might be argued that novelty production is intrinsic to agriculture as co-production, i.e. to agriculture as the ongoing encounter, interaction and mutual transformation of the social and the natural (Toledo 1992; Rip and Kemp 1998; Roep 2000; van der Ploeg 2003). Agricultural production involves the co-ordination and fine tuning of an extensive range of growth factors, including the amount and composition of nutrients in the soil, the transportability of these nutrients, the root capacity to absorb them, the availability of water and its distribution over time and so forth. Even the relatively simple cultivation of wheat involves more than two hundred such growth factors and more emerge with the growth of knowledge.

What is important is that these growth factors are not constant through time, they are not fixed since 'Genesis'. They are constantly changing

because they are regulated, modified and co-ordinated through the labour process in agriculture. For example, the amount and composition of nutrients in the soil are modified through the work of farmers (see Hofstee 1985 for an impressive discussion of farmers' management of soil fertility before chemical fertilisers were available). 'Transportability and distribution of nutrients' depend on ploughing, and the availability of water is regulated through irrigation and drainage. In the end, yields depend on the most limiting growth factor, as illustrated in Figure 1 in which the growth factors are represented as the staves of a barrel. The water level, i.e. the yield, depends on the shortest stave.

Figure 1 Growth factors composing the agricultural process of production (von Liebig 1855, see also de Wit 1992a and b)



The combination of these two points leads to a third one. That is that within their *praxis* farmers are continuously looking for the 'shortest stave', that is for the limiting factor¹. Through complex cycles of careful observation, interpretation, re-organisation (often taking initially the form of experiments) and evaluation, novelties are found and/or created. That is, existing routines are changed. This is an ongoing process: once the original limiting factor has been corrected, another will emerge as the newly limiting one.

Novelty production is, in agriculture, a highly *localised* process: time and again it is dependent on local eco-systems and on local cultural repertoires in which the organisation of the labour process is embedded.

This implies that what emerges in one place (and at a particular time) as an interesting novelty, will probably not pop up in another place or if it does it might have adverse effects or hold little or no promise.

Novelty production is very much interwoven with, i.e. emerging from and resulting in a specific type of knowledge, that is *local knowledge* or, as Mendras (1970) phrased it *l'art de la localité*. This is artisanal knowledge (*'savoir faire paysan'*, according to Lacroix 1984); knowledge about fine-tuning and mutual adjustment of growth factors through the co-ordination of tasks and subtasks. Such knowledge results in, and in turn enriches novelty production.

Socio-technical regimes

According to Rip and Kemp (1998), a socio-technical regime is the 'grammar or rule set comprised in the coherent complex of scientific knowledge, engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, ways of defining problems – all of them embedded in institutions and infrastructures'. A regime, then, specifies the way in which the societal segment dedicated to produce new technologies, new rules, new modes of doing, is working. In this way it also puts its own specific mark on its products².

Current socio-technical regimes in Western agriculture impose, in the first place, a set of supranational, national and, sometimes also, regional regulations. These specify targets (e.g. quality standards for milk; maximum ceiling for nitrogen losses per hectare; maximum level of nitrate in groundwater; required reduction of ammonia-emissions), techniques and practices assumed to be necessary to realise these targets (e.g. legally required injection of manure into the subsoil; coverage of slurry silos), timetables, control systems and sanctions. The regimes also, directly or indirectly, prescribe farming practices. These prescriptions may cover such aspects as cattle density per hectare, the architecture of farm buildings and the level of investments and variable costs associated with environmental measures and regulations. They strongly influence the material nature of fields, cows, fodder and manure (see Sonneveld *et al.* in this volume). That is, a socio-technical regime does not order only the 'social', it also orders the 'material'.

Thirdly, a socio-technical regime implies a specific trajectory for ongoing research and development. Innovations that are considered to make the emerging or established regime more coherent, more adequate and/or more efficient, will be constructed and implemented, whilst others that are considered less relevant (or not relevant at all) will remain 'underdeveloped'. More generally speaking, a regime implies also a specific distribution of knowledge and ignorance (Hobart 1993). It produces insights, databases and common rules for identifying and

proscribing what will be produced within the 'privileged way forward'. Other possible trajectories will necessarily remain in the 'shade'³.

Fourthly, a socio-technical regime links different places. It links operations at farm level with decision-making centres at national and supra-national level. It links R&D practices and the associated flow of innovations with farms and also with the involved state apparatuses, by showing what is possible and what will become feasible in the short and medium term. It also links to the public at large which, through the operation of the regime, is informed about 'progress' in agriculture. In short: a socio-technical regime links different levels, different actors and different dimensions (including the social, the technical and the material). The more coherent these interlinkages are, the more efficient the regime will be.

Regimes evolve over time. The specificity of *current* socio-technical regimes in agriculture resides in a number of elements. The regimes tend to be generic and regulations are applied regardless of specific circumstances. They are legitimised through claims on scientific grounding and aim for clear, uni-linear and unambiguous prescription and controllability as an explicit design principle. This in turn creates a preference for prescribing specific means and creates a subsequent confusion between goals and means. Moreover, the socio-technical regimes build on the previous regimes. The ones in existence today stem from the great modernisation project that reshaped Europe's agricultural systems in the second half of the 20th century. Many of the features of these regimes have directly contributed to the many-sided problems of sustainability that we face today. These features were (and remain) scale-increases at farm enterprise level, industrialisation of production and processing and the increased interwovenness with, and dependency on, markets and market-agencies. These same characteristics might also be characterised as leading to a range of disconnections. As agricultural enterprises became increasingly integrated into new socio-technical regimes, they became progressively disconnected from the parameters that had previously defined their development trajectories. These parameters included local eco-systems, local knowledge, local skills and craftsmanship, local specialities, local social relations and cultural repertoires, regional town-countryside relations and the economic relations embedded in them. The local 'grammar of farming' (or farming style as Hofstee 1948 and 1985, would have put it) became increasingly replaced by a new 'grammar', now orientated towards modernisation. At the same time it was strongly intertwined with a range of institutions, state-apparatuses, regulations, new technologies, new patterns for the social and spatial division of labour, new professional identities and new ways of problem-definition and problem-solving.

During the modernisation trajectory the driving forces of agricultural growth changed in a radical and far reaching way. Whilst for centuries it was farmers⁴ who sought for and then corrected the limiting growth factors (the 'short staves' of Figure 1), in the era of modernisation the agrarian sciences took over this role of upgrading of specific growth factors (and subsequently adjusting others). In consequence a new division of labour emerged: farming became increasingly embedded in, and dependent on, the socio-technical regimes and the process of upgrading was considerably accelerated.

In this context, the process of intensification⁵ changed drastically. Before the 1950s it was largely dependent upon the quantity and quality of farm labour⁶. Now intensification has become basically a function of applied technologies, the associated inputs and the corresponding rules and procedures. In the present socio-technical regime ongoing upgrading represents an institutionalised trajectory, but one whose path could have been different if the regime were different. In other words it has created a path dependency (North 1990; Knorr-Cetina 1996), which is produced through a range of rules, laws, organised bodies of knowledge, procedures and increasingly by available artefacts, the size and lay-out of fields, and institutionalised mechanisms for selection and reproduction of plants and animals (Wiskerke 1997; Groen *et al.* 1993; Jongerden and Ruivenkamp 1996; Bouma *et al.* 1993).

The accelerated upgrading of growth factors, and the associated intensification, specialisation, spatial concentration and scale enlargement, runs increasingly counter to a range of social and ecological limits and reactions. The more so since natural growth factors entailed in the local eco-systems are being replaced by artificial growth factors: the 'art of farming' has become increasingly disconnected from locally available resources and the eco-system, and from local socio-economic patterns and relations (Altieri 1990; van der Ploeg 1992). As a result novelty production by farmers (but not only farmers) is increasingly blocked since the production of progress is now largely taken over by those institutions that form part and parcel of the reigning socio-technical regimes.

The sustainability issue

Sustainability is, for many reasons, a key issue in world agriculture as illustrated in many declarations and commentaries (Delors 1994; Van Aartsen 1995; Fischler 1996; Cork Declaration 1996; Iacoponi 1996; RLG 1997; South Africa's Rural Development Frame Work 1997)⁷. Agriculture's achievements in the twentieth century should not be underestimated. Food production has increased dramatically as a result of technological

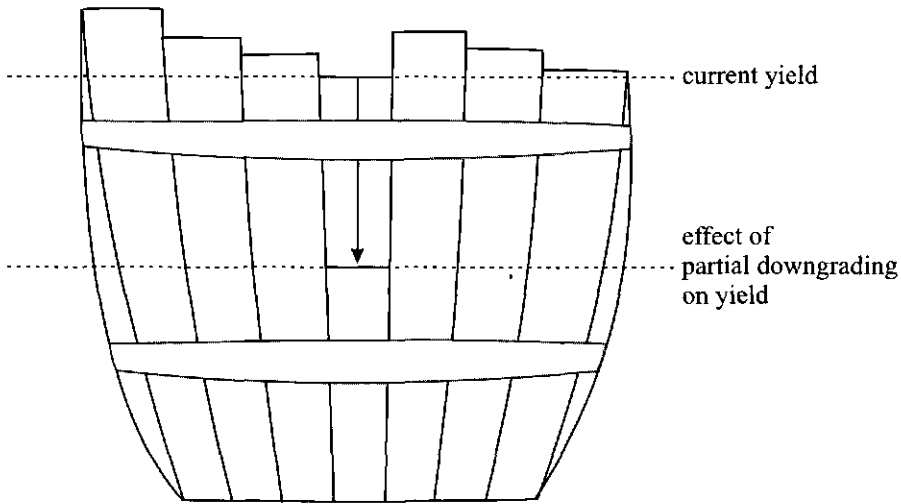
breakthroughs in plant breeding, fertilisation and biocides. World cereal yields were doubled in just forty years, an astonishingly short period relative to the thousand years it took for English wheat yields to quadruple (from 0.5 tons to 2.0 tons per hectare). But this progress has come at a price. Agriculture now contributes significantly to the general environmental crisis the world is facing. Emissions of a range of pesticides and nutrients to soil, water and air are having severe consequences in the short, but especially, the long term. Secondly, agriculture both causes, and suffers from resource depletion. Fertile top soils are washed away, destroyed and/or salinated; aquifers containing the irreplaceable stocks of sweet and clean water are dried up or severely contaminated. Highly valuable genetic diversity (plant and animal) is eroded and once gone is lost forever. The energy use of many agricultural systems increasingly contributes to the menace of global warming. Finally food quality and safety are increasingly threatened, as shown by an ever-continuing series of food scandals all over the world.

The issue of sustainability is intrinsically interwoven with socio-cultural and politico-economic dimensions and problems. Whatever processes occur, be they growth, development, stagnation, or specialisation, they all have implications for the widening and deepening problems of sustainability. Examples from this volume alone include: overgrazing, soil degradation and the associated unemployment and poverty in parts of South Africa (Adey *et al.*), the sharp reduction of biodiversity in maize production in Kenya (Hebinck and Mongo), and the massive accumulation of nutrients in parts of Europe (Reijs *et al.*). These (and many other) expressions of unsustainability are *institutionalised*. They are firmly rooted in the institutional patterns as well as in the 'hardware' (technologies, infrastructure, trading patterns, etc.) that shaped and governed developments to date (Marsden 2003). In other words: many, if not most environmental problems are the outcome of socio-technical regimes. They cannot be considered as simple deviations or errors, which can easily be addressed and resolved. On the contrary, tackling these problems implies considerable and often far-reaching adaptations if not entire shifts in the regimes that have given rise to them.

In Europe, the reigning socio-technical regimes are increasingly having to adapt their programmes in order to address the issue of sustainability. All across the EU specific regimes have been implemented that are orientated towards reducing the environmental pressure caused by agriculture. These regimes are co-ordinated at the level of the EU: which sets global targets, although the means for achieving these vary slightly between countries and sometimes regions.

One of the common features of these regimes is that they frequently aim to meet sustainability criteria through introducing additional regulations that aim to down-grade a few, specified growth factors (see Figure 2).

Figure 2 Partial down-grading (or the way current regimes try to impose sustainability in agriculture)



New societal objectives such as e.g. more bird life in meadows, cleaner ground water, fewer additives in food, or lower ammonia emissions, are translated into a reduction of specific growth factors and specified in terms of the associated tasks. Hence, mowing should be delayed, fertilisation should be reduced, manure should be applied through injection into the soil, etc. However, through such partial down-grading the carefully constructed co-ordination of the whole is disrupted and a range of discongruencies will emerge. Costs will rise and yields will drop. The dominant technological regime deals with this by financially compensating for the associated drops in productivity and/or increased costs. Schemes for landscape and nature conservation are clear expressions of this approach. While often successful in the short term the dilemma that they give rise to is becoming very clear. The more agriculture uses this approach to move towards sustainability, the higher the associated financial burden will be (ADAS 1996; Slangen 1994).

We cannot know beforehand whether or not a socio-technical regime has the capacity to resolve the problems of sustainability and to reach its professed (though sometimes conflicting) goals. This will depend on many factors, a few of which we refer to below:

- The degree to which agriculture has been effectively aligned and standardised. If a considerable degree of heterogeneity exists (due to, among other things, 'promising pockets' of not yet disconnected and/or re-connected agricultural systems, ref. Adey *et al.* in this volume), a generic environmental policy and, consequently, a coherent socio-technical regime is likely to run counter to the variety of real life situations. This is more likely if the development trajectory is highly institutionalised and, therefore, inflexible.
- The degree to which the proposed solutions and innovations are in line with the interests and rationale of the involved actors.
- The degree to which the preferred trajectory is rooted in a comprehensive understanding of the complexities of farming and its interactions with living nature. The less this is the case the greater the chance that unexpected and unintended consequences will emerge and hamper, or even undermine, the proposed trajectory⁸.

Alternative roads towards sustainability

There might be other roads to sustainability. Many of these are emerging from current forms of novelty production. In the current context (of harnessing regimes) novelty production involves an ongoing search, through practice, for adequate ways to handle environmental problems (including the problems introduced by the rules, procedures and artefacts stemming from the socio-technical regime). Frequently there is a clear distinction between what we term 'novelties', which result from that search, and the innovations and prescriptions introduced by the reigning regime. These novelties emerge directly from farm labour processes and the associated local knowledge. That is, they are highly adapted to local particularities⁹. Novelties also pop up as organisational and/or technical devices that a) fit into the existing processes of production (albeit transforming them) and b) render considerable gains not only in terms of sustainability but also in economic, institutional and social terms. In short: innovations and novelties have different 'life-histories' and are, therefore, quite often different in substantive terms as well.

A brief example (that will be further discussed in chapters 7 to 9 of this book) will help illustrate this point. It is derived from dairy farming in the Northern Frisian Woodlands (in the Netherlands). Farmers here operate in a small-scale landscape, characterised by hedgerows and a micro-relief that is associated with relatively wet and dry soils existing close to each other. The style of farming economically (that is, opting for a low use of external inputs) is very typical for the area (van der Ploeg 2000). A straight forward application of the rules and procedures imposed by the socio-technical regime would cause considerable problems here, or

possibly even produce a series of highly counterproductive effects. Convinced of the case for, and inevitability of, more sustainable approaches farmers (after an initial period together with involved scientists and politicians) here developed a range of new approaches. Building upon local experiences they proposed the production of 'better manure', to be realised with adapted feeding techniques, additives and different grassland management strategies¹⁰. The production of 'better manure' was understood, presented and eventually realised as a promising alternative to the 'end-of-pipe' technologies proposed by the reigning regime. Thus, producing better manure became a road towards sustainability that differed remarkably from the prescribed method of injecting manure into the subsoil. Other novelties accompanied this: a new machine for spreading manure was developed, tested and in the end widely used and region-specific programmes for conserving natural and landscape values were designed and implemented¹¹.

Through all these novelties the farmers were able to meet the generic environmental goals more quickly, and in a far more convincing way, than many other areas of the Netherlands. Probably even more important, they succeeded in combining these 'environmental gains' with considerable social, economic and institutional gains. Central to all this was the opportunity that the concerned farmers could develop their own local ways of reaching the general environmental goals (see below). This required considerable flexibility, creativity and innovativeness on the part of the farmers because the environmental goals were generic in character and largely imposed by EU headquarters in Brussels. The farmers could easily have opted to criticise the environmental threshold values for nitrate in groundwater and the associated application rates of organic manure as being too severe and harmful to the economic feasibility of farming operations. The same can be said about the prescribed reduction of ammonia evaporation from manure. Rather than challenge these thresholds in court, as has been done elsewhere (resulting in futile battles with bureaucrats) the farmers made a great leap forward by taking these thresholds for granted and by developing – through a range of interconnected novelties – new management practices that would meet these thresholds. As it turns out, economic farming is possible under such conditions. In fact, management is improved and results in more sustainable production systems.

Niches and strategic niche management

The practices discussed above, the associated learning processes and the ongoing production of other, sometimes promising novelties, were only made possible by the gradual but persistent creation of a niche. A niche is *a protected space in which novelties can mature* (Kemp, Schot and Hoogma

1998). The particular niche developed in the Northern Frisian Woodlands was an environmental co-operative (see Stuiver and Wiskerke in this volume and also Renting and van der Ploeg 2001)¹². These co-operatives emerged from lengthy negotiations between farmers and authorities, resulting in a contract between the Minister of Agriculture and local farmers. The Minister granted farmers the necessary space for manoeuvre, to develop and mature their own means or novelties on the understanding that the farmers would meet, if not exceed, the general environmental aims more quickly and more efficiently than elsewhere. The thus established protected space (or niche) made it possible to check whether the previously hidden novelties had the potential to become new constellations that not only showed promise, but demonstrated their operational effectiveness.

The niche developed further and consolidated itself through the construction and institutionalisation of a range of new social relations, networks, the development of new (local) knowledge, the capacity to 'deliver', etc. The creation of a governing board for the co-operative opened opportunities for creative and active farmers, which had a major effect on the activities of everyone. Progressive farmers led and inspired the others. In the absence of such a co-operative, peer pressure between the many farmers in the area might have stifled novelty production, as farmers watch each other closely and those that are wary of change can easily be the most vocal and appear as the voice of wisdom thereby inhibiting change. Under such conditions the tone is set, not by innovative farmers, but by the most conservative ones, who can easily sway local opinion. It is important to stress that without the niche provided by the environmental co-operative the development of novelties would have been impossible. Making better manure and improving soil biology (through, amongst other things, on-surface application) would simply not have been options if manure injection became obligatory. The same goes for many of the other novelties.

This book will also discuss several other niches. Some of these have been created deliberately, as is the case with the *Zeeuwse Vlegel* group (Wiskerke and Oerlemans, this volume) and the 'wine routes' in Tuscany (Brunori *et al.* this volume). Other niches are, as it were, the unintended outcome of specific regimes, as is the case in Luo Land in West Kenya (Mango and Hebinck, this volume). The 'promising pockets' in South Africa, described by Adey, Kotze and Rijkenberg are another example.

Novelties as radical innovations

From the argument developed so far two opposing positions emerge: the socio-technical regime vs. the niche. In a way this contrast comes down to another one: innovations vs. novelties. Here the notion of innovation

strongly links with regime as innovations fit into the prevailing regime, and are often, although not exclusively, produced by the institutions forming part of the regime and neatly follow its 'grammar'. Innovations are incremental. They build upon the state-of-affairs, the logic and the grammar. They are also incremental in so far as they represent the next small step forward along predefined lines. Novelties on the other hand are, as it were, radical innovations. They entail (at least potentially) the possibility of a regime-shift. Novelties are, in one or more ways, 'at odds' with the reigning regime. They are not easily integrated and emerge, more often than not, from the 'periphery' of the prevailing regimes.

Although in general terms there are differences between novelties and innovations (these concern amongst other things their different genesis¹³, grammars¹⁴ and horizons of relevance¹⁵) the contrasts that we have drawn between them are not necessarily that clear cut. Throughout agricultural history emerging novelties have been explored by extension services, individual scientists and/or state services. They have nurtured these novelties, unpacking them from the particularities of time and space, testing them and, where possible, improving them so as to make further dissemination possible¹⁶. Furthermore, many of the institutions within the current regimes also are involved in novelty-production.

That is, regardless of the differences between novelties and innovations, the two might intertwine and complement each other very well. The current problem, though, is that the two are increasingly separated, if not diametrically opposed to each other in terms of validity, scientific grounding, effectiveness and competitiveness. Some promising changes in agronomic research do incorporate novelties as part of a process of prototyping farming systems. These studies first pay attention to local expertise, which is then followed by expert input on those areas that need further clarification. In other words, research of the classical type is intended only to fill in the remaining gaps (Bouma 2001a and b). This is in contrast to the major thrust in academic agronomic research, in which detailed research is often the starting point, that is used to generate series of coefficients that characterise various hypothetical farming systems that appear, on paper, to fulfil criteria for sustainability. With no relation to real-world systems and with little opportunity for farmers to participate in their development, systems generated in this way are bound to die in abstract beauty.

The troublesome relations between regimes and niches compose a key theme of this book. We believe that these troubled relations (which will be amply documented throughout this book) represent a major problem. Firstly, because a considerable amount of innovativeness (and corre-

spondingly: a range of potential solutions) is lost in this way. Secondly because regimes will lose their legitimacy: the trust required for their smooth functioning will be eroded. Thirdly, the transaction costs associated with the functioning of agriculture and food production will rise to levels that are in the end (if not already) far too high.

We also believe that, through strategic niche management, better ways might be developed to handle the current contradictions and tensions. In the final chapter of this book we will systematically address this theme, through revisiting and re-analysing the empirical case studies that centre on the 'difficult marriage' of regimes and niches.

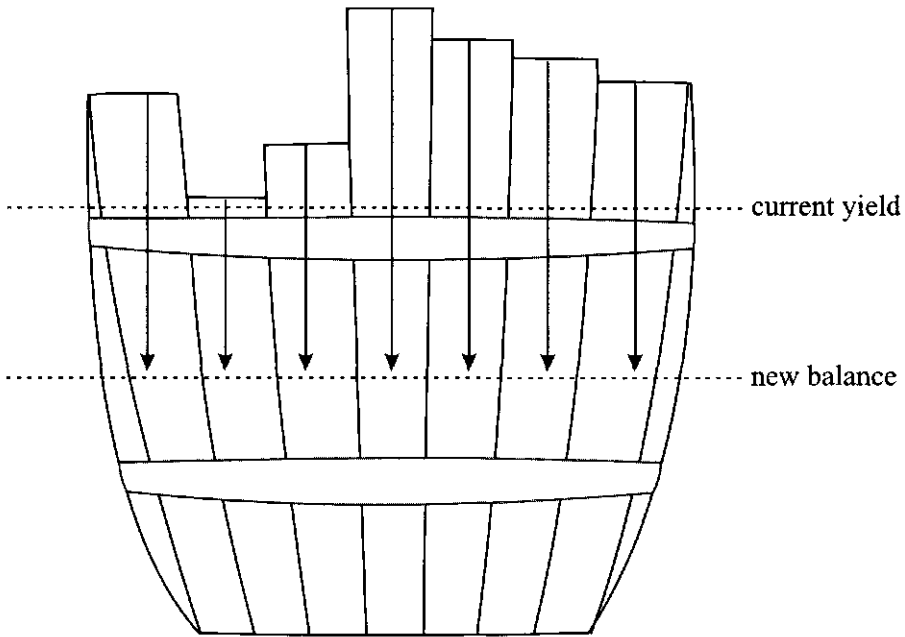
Strategic niche management has implications that extend way beyond agriculture. The role of science in post-modern society is changing. Rather than providing answers to questions that have been phrased by scientists themselves, scientists – in order to survive – now have to take part in interactive processes with a wide variety of stakeholders engaged in creating joint learning opportunities. Scientists have to do more in future than solve self-defined problems. They also have to explain, to negotiate, to clarify and to build on the novelties they observe and/or fashion.

Re-balancing co-production

There is, we believe, an important theoretical background to be discerned within the current processes and forms of novelty production. Several of the empirical expressions of novelty production discussed in this book entail adopting a radically different perspective. In contrast to the current approach, which focuses on *partial* downgrading, whilst continuing to upgrade other growth factors, the case studies entailed in this volume explore the possibility of an overall, well co-ordinated and congruent *re-balancing* of all relevant growth factors. This is achieved by a systematic and integral reorganisation of the labour and production process, that aims to create a new balance that allows for farming to become both ecologically and economically sustainable. Instead of one growth factor, the whole range of relevant growth-factors is 'shortened', re-structured and brought back in line (see Figure 3)¹⁷

A brief illustration might help to clarify this notion. In many places grassland management is adapted, for instance, to allow for the development and maintenance of natural values (flora, birds, animals) or the conservation of water in the subsoils or to keep marginal lands under cultivation in order to prevent ecological destruction. Consequently, fodder produced in these grasslands will have a lower energy value compared to fodder produced under 'optimal' conditions. However, if the animals have been bred to be dependent on high energy fodder this creates a discongruency. This can be resolved in two ways.

Figure 3 Rebalancing as radical alternative



In the current approach the farmer is compensated financially so that he or she can buy the required 'energy' elsewhere. The alternative would be to select (that is to create or 'build') a new breed whose nutritional demands correspond more closely with the changed grassland production. Evidently such an adaptation will require a range of further changes within the farm, as well as in the interrelations between the farm and the economic and institutional environment in which it operates. All the relevant subsystems and interrelations have to be reorganised so as to create a new equilibrium (van Bruchem 1998).

There is some evidence, partly theoretical, partly empirical, that such new equilibria do not necessarily imply an overall reduction in income levels (see e.g. van der Ploeg 1994a and 1994b; van der Ploeg *et al.* 1997; and ILEIA studies reported from the Third World: Reijntjes *et al.* 1992; Haverkort *et al.* 1991; Compas 1998). A well integrated overall process of re-balancing might imply substantial cost-reductions and may generate new income-opportunities (Broekhuizen *et al.* 1994 and 1997). However, the insights into and experiences with such an overall re-balancing remain very scattered in the literature. Equally no well-articulated theoretical representation of this perspective has yet been developed. This is a reflection of the dominance of the prevailing technological regime (see for a general discussion North 1990 and Hobart 1993).

Hypothetically, an overall re-balancing (as illustrated in Figure 3) might result in income improvement. Apart from immediate savings (less fertiliser, less concentrates), a range of indirect effects may emerge. The 'lowering' of a range of growth factors might considerably reduce the total stress in the productive system, which might translate into a reduction of diseases (both in plants and animals). In turn this may reflect in lower expenditure for veterinarian assistance and intervention and in prolonged longevity, which in its turn might help to reduce the costs of breeding heifers to replace cows, etc. When the 'lowering' of a range of (artificial) growth factors goes together with the re-introduction of nature, these effects might be even stronger (soil biology and the associated autonomous nitrogen delivery capacity of the subsoil play an important role in this respect; see Verhoeven *et al.* 1998). The extent to which these effects will emerge depends on the 'art' of re-balancing and the skills of those involved.

The methodological starting point of the case studies entailed in this volume is, in itself, simple but powerful. It is related to the fact that *in practice* many farmers realise forms of re-balancing, in order to adapt their particular farm enterprises to the particular ecological and/or economic situation in which they operate¹⁸. Re-balancing can also occur as a result of farmers trying to adapt their business better to the peculiarities of the products they produce (Ventura and van der Meulen 1994; Roep 2000), or adopting new strategies¹⁹. *In situ* experimentation and local knowledge play a crucial role here (Box 1990; Stuiver and Wiskerke in this volume). An impressive range of sometimes astonishing novelties²⁰ is the outcome of this innovativeness of farmers. However, these mostly remain as 'hidden novelties' because the prevailing scientific regime does not yet recognise that such novelties are the key to effective innovations rather than a nuisance that distracts from the grand-designs that have been constructed scientifically, following the established regimes.

This book therefore addresses a number of interrelated themes. First of these is studying the relationship between novelty production and rebalancing. A second is exploring the rigidity and flexibility of relations within the dominant agricultural regimes in the Netherlands, South Africa and Italy. Special attention will be given to the question of why and how so many novelties remain 'hidden' or, *vice versa*, under which conditions some novelties are absorbed, transformed and generalised through the reigning socio-technical regimes. The role of science will receive particular attention. Thirdly attention is focused on some 'strategic niches' in which favourable conditions exist that make it possible to go beyond the impasse that exists between the production of novelties, on the one hand, and the technological regime on the other.

This leads to a discussion of the implications of 'strategic niche management' (Kemp, Rip and Schot 1997) on the ways in which agricultural research is currently organised.

The AGRINOVIM programme

This book stems from a five year, international research programme funded by the Dutch NWO, in which the Universities of Perugia (Italy), Natal (South Africa) and Wageningen and Twente (both in the Netherlands) are participating. AGRINOVIM focuses on three areas of study each containing, in one way or another, a particular niche within which novelty production is taking place. These are the 'promising pockets' in South Africa, the Apennine mountains in Abruzzo, Italy and the Northern Frisian Woodlands, where the already introduced environmental co-operatives are located. In each of these three areas the research centres on processes of novelty production, on the complex interrelations between niche and regime and on forms of strategic niche management.

In each of these niches sustainability emerges as a specific problem. In the Abruzzo, for instance, the ongoing decline of dairy farming and animal breeding from the mountain zones is seen as a priority problem requiring specific interventions and new institutional relations. Without farming (and especially grazing) it is impossible to maintain the rich but fragile eco-systems (Biondi 1996; Meeus *et al.* 1988). There is a clear need to design farming systems that fit the particular ecological conditions, yet also need to be capable of existing within the increasingly globalised market conditions (Ventura 2001 and more generally Long 1985 and 1996).

Given the support of the *regions*, the interest of the involved farmers and the availability of the extensive experimental facilities of the University of Perugia, the prospects of developing new and proper techno-institutional designs (that regard both the further maturing of novelties and the strategic management of niches) are relatively encouraging.

The same applies to South Africa. Here, there is a considerable need to develop new farming systems that include indigenous flora and fauna (many species are to be considered 'novelties') and which can also offer new employment and income facilities to resource-poor farmers (Lipton *et al.* 1996). At the same time the land reform framework and the experience and the experimental facilities of the University of Natal in Pietermaritzburg provide a positive institutional setting for the design of farming systems based on integral re-balancing.

The third niche is located in the Frisian Woodlands, an area in the North of the Netherlands where farmers have created the 'environmental co-operatives' discussed earlier.

On a theoretical level the AGRINOVIM programme aims to integrate previously largely disconnected disciplines and bodies of literature. These are neo-institutional economics²¹, rural sociology²², social constructivism (or actor network theory)²³ and classical agronomy²⁴. Multi-level analysis is central to this process, and is used to simultaneously address (1) 'material realities' (at the micro-level) such as fields, animals, grassland production and manure, (2) social realities such as the evolution and differentiation of farming styles (at the meso-level), (3) macro-level patterns of interaction, such as the interrelations between farms, markets and institutions and between 'novelty production' and technological regimes and (4) the impact of collective actions that aim to secure a definitive shift in techno-institutional designs towards new forms of agricultural development. In (4) the complex interactions between micro, meso and macrolevel play a central role (Knorr-Cetina 1981).

We acknowledge that the proposed integration of these disciplines into one multi-disciplinary approach is an ambitious one. Still, a serious effort of this nature is long overdue and should no longer be postponed. Many papers and governmental bulletins mention the importance of multi-disciplinarity without exploring the practicalities of this approach. In this respect Bouma (1999, 2001a, 2001b) emphasises the need for each discipline to define its expertise (in different degrees of detail) in order to clarify its potential role within the disciplinary toolkit. This approach can avoid the problem of different disciplines attempting to communicate on totally different wavelengths. Bouma also advocates use of research chains which start with user expertise and expert knowledge at different spatial levels and then draw on detailed research to fill in the gaps. This is in stark contrast to much current research, which starts from a detailed, but uncontextualised, approach (which is a tested means of securing publication in single disciplinary scientific journals) but which does not necessarily connect with the real world and the novelties emerging from it.

The contents of this volume

This book is divided into three sections. The first sets out some of the major theoretical lines needed for a proper understanding of novelty production and niche management. Moors, Rip and Wiskerke summarise the international literature on the dynamics of innovation and systematically introduce the central concepts of regime, niche and novelty. Ventura and Milone broaden the theoretical discussion from a neo-institutional perspective. They argue that time and again novelties entail and imply *boundary shifts*: in which the boundaries between the farm enterprise, on the one hand, and markets and market agencies, on the other, are redefined and reorganised. Sometimes these shifts are small

ones, sometimes more fundamental. Boundary shifts can sometimes make a considerable positive contribution to the incomes realised from the re-balancing that occurs as a result of novelty production. The last chapter of this section (by Stuiver, Leeuwis and van der Ploeg), focuses attention on local knowledge and its development as crucial pre-conditions for much novelty production

The second section concentrates on novelty production in Dutch dairy farming, focusing on the VEL and VANLA co-operatives in the Northern Frisian Woodlands. First Stuiver and Wiskerke synthesise the ongoing but often fragile process of novelty production, stressing that novelty production results in an expanding *programme of change* – a programme that is one of the fruits of the initial *seeds of transition*. Then Reijs, van Bruchem, Lantinga and Verhoeven explore the technicalities of new pathways towards sustainability, focusing on the reduction of N surpluses. Their discussion is followed by a new theoretical perspective on ‘the role of land in agriculture’ (by Sonneveld, Veldkamp and Bouma). Through the introduction of the concept of *phenoforms* they build, on the practical progress realised in the VEL and VANLA area, whilst also offering a new conceptual ‘bridge’ to link theory and practice.

The third section presents a range of contrasting experiences from different parts of the world. First Adey, Kotze and Rijkenberg discuss the radical transition in agricultural research, extension and policy in post-apartheid KwaZulu Natal. In this rapidly and radically changing context of agricultural production they describe and analyse the emergence and development of *promising pockets* (i.e. niches) for sustainable agricultural and rural development. This is followed by a Dutch example (*Zeeuwse Vlegel*) on the construction of an alternative short food supply chain (wheat and bread). In this Wiskerke and Oerlemans analyse the dynamics of building a niche for sustainable baking wheat cultivation *vis-à-vis* the prevailing regime of wheat breeding, production and processing. Next the story moves to Spain. Remmers gives a detailed case description of the development and marketing of new cheeses in a mountainous rural area of Southern Spain (Alpujarra). This illustrates the crusade that rural innovators must embark on in order to succeed, and the qualities they must possess to do so. Central to Remmers’ argument is the concept of serendipity, i.e. the process of unexpected transformation from something marginal into something valuable. In his contribution Remmers develops the concept in terms of an actor’s capacity to perceive, at the appropriate moment, what is valuable for the success of a rural enterprise and argues that this is a crucial capacity in processes of alignment. The Spanish case is followed by an example from Kenya, in which Mango and Hebinck explore the relationship between culture, markets, technology and

agriculture. They demonstrate the interfaces between the cultural repertoires of local people and the scientific repertoires of research institutions. In their contribution, Mango and Hebinck seek to explain how local culture 'reads' local as well as scientific knowledge and new technologies (in this case the hybrid maize varieties and accompanying packages). They also explain how local culture forms part of a 'defence line' against the practices that are introduced and favoured by scientific knowledge. In the last chapter of this section Brunori, Galli and Rossi, use the example of wine routes in Tuscany, to explore *collective action* at the local level. They identify that the capacity to create alliances with the outside world is one of the key elements for success in novel rural development practices. Collective action enables small entrepreneurs to mobilise social relations, to improve their economic performance and create new opportunities for growth. This is, according to the authors, due to the fact that collective action in a wine route results in *coherence* and *synergy*.

This volume concludes with an epilogue in which Roep and Wiskerke propose a more pro-active framework for studying and managing the co-evolution of technical and institutional change. This framework, which is an attempt to integrate the different theoretical lines discussed in the first section, can be used both as an analytical tool and a reflexive management tool. The epilogue summarises the strategic lessons learned from the empirical examples for novelty creation and niche management in agriculture.

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Notes

1 Of course this depends on historical conditions and, more specifically, on the social relations of, and in, production (Hayami and Ruttan 1985)

2 Scientific institutions and 'expert systems' are important cornerstones of today's regimes (Giddens 1990; van der Ploeg 2003). Hence, it is not only the socio-technical regime that affects the type of innovations being realised, but also the regimes of science itself. Despite claims of academic freedom, most scientific disciplines have clear sets of written and unwritten rules and different 'schools of thought' that strongly define the type of scientific activity that will be rewarded by the system. Many academic journals are still disciplinary in character and thrive on ever more detailed investigations that have, at best, only remote relevance to real world processes.

Thus a technology is composed of a semi-coherent complex of scientific knowledge, engineering practices, production process technologies, product characteristics, skills and procedures, and institutions and infrastructures (Rip and Kemp 1998; Kemp *et al.* 1994 and 1997; Dosi *et al.* 1988 and 1993; van Bentum 1995; Buttel and Goodman 1989; van der Ploeg 1987; Rambaud 1983). Technological regimes have been characterised in agrarian sciences as TATE, or Technological Administrative Task Environments (see Benvenuti 1982, 1989 and 1990), producing an ongoing flow of techno-institutional designs which 'co-order' both the material and the social world (see Bijker and Law 1992; Lente 1994; van der Ploeg 1993; Vacca 1989; Bouma 1993).

3 That is, a regime defines to a considerable degree the agendas for scientific and applied research. In that sense a regime also links the present with the future and the future with the present (see van der Ploeg 2003).

4 Every now and then assisted by the representatives of classical agronomy as, e.g., Zacaria Iahia 1802; Barigazzi 1772; Cuppari 1969 and Marengi 1923.

5 Intensification refers to the dominant type of agricultural development, that is to produce more output per object of labour; that is per unit of land, per animal, per vineyard, etc. Upgrading of growth factors is evidently essential to intensification.

6 This implies that also the specific patterns of communication, the interests, prospects and values of those involved, etc., play an important role. See for a further discussion Beaudéau 1994; Engel 1997 and Leeuwis 1993.

7 The international development of precision agriculture provides an intriguing footnote to the above discussion. Clearly, precision agriculture is part of the dominant technological regime. However, by using information technology and global positioning systems, management can be varied in space within a field focussing on local demands of crop which, as any farmer knows, vary considerably within a field. By fine-tuning management practices within a field to the varying needs of the plant, which can also follow guidelines of organic agriculture if so desired, resource use and negative environmental side effects to soil and groundwater are minimised (Bouma *et al.* 1999).

8 New regulations that oblige farmers in the Netherlands to inject manure into the subsoil provide an example of this. Such an operation, which is a typical example of the logic of the current regime in Dutch agriculture, are intended to reduce ammonia emissions to permitted levels. However, some experts claim that a considerable part of the injected ammonia later evaporates through the stomata of the grass-leaves (Erisman 2000). Injection might have destructive effects on soil biology (thereby reducing the autonomous nitrogen delivery capacity of the subsoil, so that far more fertilizer and/or concentrates are needed). These two factors may undermine the rationality of injection and erode the legitimacy of the institutions prescribing it. The underlying problem here is that environmental policies were constructed with insufficient insights into the practices of farming. What was most noticeably missing was insight into promising deviations.

9 And not, as is the case in the institutionalised production of innovations, more or less disconnected from local particularities.

10 Eshuis *et al.* 2001; VEL/VANLA *et al.* 1997 and more generally van Bruchem 1997 and van Bruchem *et al.* 1998.

11 This is a relevant detail especially since the straight forward application of official environmental legislation is, in several situations, at odds with nature conservation objectives (especially bird life) as well as with landscape preservation.

12 More detailed reading, especially on the crucial 'take off' stage of the first co-operatives can be found in de Bruin 1997; de Bruin *et al.* 1994; Hees, Renting and de Rooij 1994; VEL/VANLA *et al.* 1997; Verhoeven *et al.* 1998; Renting and van der Ploeg 2001 and van der Ploeg, Frouws and Renting 2002. An international comparison, that also considers these co-operatives, is outlined in OECD 1996.

13 See Wiskerke (1997) for the case of wheat varieties and van der Ploeg (1993) for the case of potato-breeding in the Andes.

14 A beautiful analysis is contained in van Kessel (1990). See also Darré (1985) and Dupré (1991).

15 Conklin (1957).

16 Engel (1997), who made an extensive study of extension practices in the Netherlands estimates that, of the total 'supply' of innovations offered by the extension services between 1960 and 1980, some 40 per cent were directly derived from the insights that extensionists obtained from experimenting and/or pioneering farmers. A further 40 per cent was obtained from other extensionists who in turn had got a considerable degree of their ideas directly from other farmers. Only some 20 per cent of the new ideas followed the canonical line that goes from basic research, via applied research to extensionists. As far as applied research is concerned van der Zaag, once the leading expert in potato breeding and cultivation, estimated that some 80 per cent of all major changes in Dutch potato industry after WW II, initially emerged as farmers' bred novelties. These novelties then became, as it were, 'absorbed', 'unpacked' and 'reformulated' by the research institutes (see van der Ploeg 1987). Vijverberg (1996) in his turn, reconstructed the 'life-histories' of some of the main innovations in the Dutch horticultural sector. He showed that only when there was a strong interaction between farmers and researchers, did the resulting innovations prove to be successful. Nonetheless, the dominant (intellectual) model that represents the flows of communications, the interaction of blocks of knowledge, etc., and which strongly informs agricultural policy in this respect, remains at odds with this empirical situation.

17 From a theoretical and methodological point of view, the graphical representation contained in Figure 3, entails at least two major problems. The first is that many farms cannot be conceptualised as just one 'barrel' – they are, instead, a series of connected and communicating barrels. Reference to a farm familiar to the authors, the Ivy Farm in South Africa, might illustrate this. The Ivys had carefully controlled grazing camps for their Bonsmara beef breed. These beef animals were slaughtered and sold in their own butchery. In addition they had a fattening beef feedlot which also contributed to their butchery. The Ivys therefore had a 'barrel' for the grassland, another for the Bonsmara beef feedlot and yet another for the butchery. These different 'barrels' had to be co-ordinated in a precise way. At the same time the interrelations might change. Recently, the Ivys have sold their Bonsmara herd, reduced the size of the feedlot and introduced game hunting onto the farm. Their butchery now handles game and trophies. Fenced off grazing camps have disappeared. Overall, family income has increased through these changes, whilst farming is now more sustainable and natural resources are used more intensively and more efficiently.

The relevance of this illustration relates to the second point. That is that the 'staves' of the barrels cannot be seen (as is the case in the classical Von Liebig model) as independent from each other. Reducing one or some 'staves' (or growth factors) in one particular 'barrel', might well lead to the increase of other 'staves' in other parts of the farm (other 'barrels').

Doing away with the fences, for instance, created considerable opportunities for game farming. This can also apply to single 'barrels': decreasing one stave may well increase (or decrease) another dependent one. In novelty production we are frequently confronted with such sets of dependent variables. This means that the lowest stave does not determine yield or income; lowering it may in fact push up yields or income. For the sake of simplicity, though, we stick to Liebig's method of representation. However, when discussing and illustrating the 'lowering of a range of growth factors' (further on in this text), these two points underlie our arguments.

18 These adaptations to different specificities are reflected in the impressive heterogeneity of agriculture; see in this respect Almekinders, Fresco and Struik 1995; Beaudeau 1994; Bouma 1994 and 1997; Bowler *et al.* 1995; Hebinck 1990; Jollivet 1988; Kerkhove 1994; Leeuwis 1989; Manolesco 1987; Roep *et al.* 1991; Steenhuisen de Piters 1995; Wiskerke 1997; Remmers 1998. In this respect it is telling that several of these studies refer to particular 'novelties'.

19 Broekhuizen *et al.* 1994 and 1997; Marsden *et al.* 1992; Drooger, Fermont and Bouma 1996; Droogers and Bouma 1996.

20 Box 1990; Dupre 1991; Leeuwis 1993; Isart and Llerena 1997; Compas 1998; van der Ploeg and Long 1994; van der Ploeg and van Dijk 1995; Alders *et al.* 1993; Haverkort *et al.* 1991; Osti 1991 and Swagemakers 2002.

21 Especially as far as this refers to the structure and dynamics of agricultural enterprises and the relations in which they are embedded (Saccomandi 1991 and 1998; Pennacchi *et al.* 1996; Bagnasco 1988). In this context special attention needs to be paid to issues of value adding (Ventura and van der Meulen 1994; Ventura 2001) and the analysis of 'funds and flows' (Georgescu-Roegen 1972; Romagnoli 1994). Equally important is the analysis of innovative processes generally and novelty production especially in terms of transaction costs. See Ventura and Milone in this volume.

22 Especially those parts that regard the dynamics, heterogeneity and malleability of the processes of production and labour (van der Ploeg 1990; Long 1985; Toledo 1992), the grammar, dynamics and reach of local knowledge (Conklin 1957; Darre 1985; Leeuwis 1993; van Kessel 1990; van der Ploeg 1987) and the creation of novelties (Remmers 1998; Roep 2000; Osti 1991; Swagemakers 2002).

23 Especially those parts that concern co-production and co-evolution (Rip 1995; Rip, Misa and Schot 1995; Knorr-Cetina 1996; Latour 1991 and 1994; Callon 1986; Law 1994) and technological regimes and path-dependencies (Rip and Kemp 1998; North 1990).

24 Especially as far as it implicitly focuses on key issues of co-production as the interactions between agriculture, soil and ecology (Bouma 1994; Droogers and Bouma 1997), the socially constructed interactions between soil biology, grassland production, cattle selection, cattle feeding and manure production (van Bruchem *et al.* 1997b; Penacchi *et al.* 1996) and the inclusion of indigenous flora and fauna into different farming systems (Biondi 1996; Conklin 1957).

2 The Dynamics of Innovation: A Multilevel Co-Evolutionary Perspective

Ellen H.M. Moors, Arie Rip and Johannes S.C. Wiskerke

Introduction

There is a long tradition of institutional design, in practice and as a challenge for social scientists (e.g. Ostrom 1990, 1992). Many studies and analyses of the subject have been made, often drawing upon neo-institutional economical theory (for an authoritative review see Weimer 1995). However these studies have often insufficiently taken into account the role of material aspects in the socio-technical design activities, which are increasingly important in today's world and in the case of agriculture, have always been important. While the importance of the socio-technical is occasionally recognised (for example in energy policy, cf. Arentsen and Künneke 1996), the technical and material often tend to be accepted as given and thus not subject to examination. This point has been made before in science and technology studies, most forcibly by Latour (e.g. 1992), but little attention has been paid to the possibility of developing systematic technico-institutional design. Occasionally the possibilities of this have been explored, but from the context of specific domains, for example computer-supported collaborative work (see e.g. DeSanctis and Poole 1994; Rogers 1994).

Further related entrées to the subject have been provided by technology assessment (TA), in particular constructive technology assessment (CTA) (Rip *et al.* 1995). Schot and Rip (1997) emphasise the importance of feedback within technological developments (which in turn is based upon an understanding of their socio-technical dynamics) which occurs in interaction with assessment of possible impacts, thereby generating an iterative learning process. Out of this traditional concern of TA with identifying potential impacts, there is now a growing interest in influencing (socio-)technical development. A number of ways of approaching this have been identified.

While such studies have made important contributions to understanding the dynamics of innovation, most of these studies and 'natural' technico-institutional design activities have not explicitly or systematically located themselves within the context of existing and evolving technical regimes.

In some instances the need for a regime change is identified (for example in the motorcar regime, or with respect to problems of global climate change) but the means for examining how such a change might be achieved is rarely explored. Available historical and retrospective sociological studies of the emergence, stabilisation and transformation of regimes (for interesting examples see: Marvin 1988; Stoelhorst 1997; Van den Ende 1994; Van de Poel 1998) provide some basis for understanding positive and negative design heuristics ('do's' and 'don'ts') that contribute towards this. Kemp *et al.* (1997) have further contributed to this, by conceptualising transition paths from an existing regime to a possible (and hopefully better) one. They identified strategic niche management as a particularly effective approach in achieving this. Drawing upon the typical approach of selecting and studying interesting 'natural' cases, it goes further and sets up 'experimental' cases (most often, by intentionally modifying 'natural' cases) and evaluating them (Schot *et al.* 1996; Kemp *et al.* 1998; Weber *et al.* 1999; Hoogma *et al.* 2002; see also Rip 1995).

In order to develop a technico-institutional design method, which touches on both the material and the socio-institutional components of novelties (in this case agricultural developments) and, especially, on the complex interrelations between the two, we argue that a dynamic, multi-level, co-evolutionary, perspective is required. The basic idea is that the diverse innovation processes and technology choices at the local level accumulate as technological developments at the societal level. In developing such a perspective we take the multi-level, multi-actor and multi-aspect dynamics of socio-technical change into account, with the focus on the interaction between technology and society, conceptualised as the process of co-evolution or co-production in which technology and social context interact and change. Accordingly, a multi-level analysis simultaneously addresses material/technical realities, patterns of socio-technical interaction and the impacts of collective action (collective experiments) that aim to secure a shift in technico-institutional design towards new forms of agricultural development.

In order to set up new structures and ways of achieving technico-institutional design in agricultural development, we need to understand the co-evolutionary dynamics of interaction between the natural, the technical and the institutional. This is of particular relevance when seeking changes in the direction of the existing regime (as is currently with attempts to turn the present industrial agricultural regime into one that is sustainable). We also need to understand the relationship between 'novelty creation' (generated within agriculture), its nurturing or repression (within the institutional sphere) and regime evolution or transition (widespread acceptance and adoption across society). This again merits particular attention when the novelties hold promise, but

appear frail or inconsequential in comparison to the dominant regime – having the characteristics of what Mokyr (1990) and Stoelhorst (1997) call ‘hopeful monstrosities.’

A better understanding of the co-evolutionary innovation dynamics in agricultural practices can be reached by taking a multi-level perspective on innovation processes, studying the overall transition process in agricultural regimes. The next section of this chapter describes on transition processes. Next, we focus on the underlying dynamics of socio-technical innovation processes, and in particular upon the general patterns and mechanisms involved in transition processes. The fourth section of this chapter provides an introduction to the concept of strategic niche management. The chapter ends with some concluding remarks on the way in which transition processes might be most effectively managed.

A multi-level perspective on innovation: studying the overall transition process

Socio-technical developments in various economic and societal sectors, such as households, transport, energy, industrial production and agriculture, are required in order for us to meet the challenge of sustainable development. Although these sectors have the potential to become sustainable, through socially and environmentally benign technological developments, they are presently important sources of environmental degradation and are far from sustainable. The agricultural sector, for example, pollutes its environment by emitting high amounts of ammonia, nitrate, and pesticides, reduces biodiversity and uses a lot of energy for crop growth and transportation. The necessity to break the current trends in agricultural practices requires fundamental renewals and breakthrough changes, changes that will take decades. So it is important that the process of change should be initiated as soon as possible (Jansen 1993; Moors and Mulder 2002). Therefore, a transition is necessary, from a scale-intensive, specialised, high production-oriented agriculture system to a new, more sustainable agricultural system, whose features would include minimal environmental degradation, minimal use of external inputs, multifunctional soil use, and embeddedness in local ecological conditions and cultural practices. Such a regime-shift in agriculture is an essential component of any programme for sustainable development.

Transition processes

Transitions are regarded as large transformation processes in which large parts of society change, in a fundamental way, over a generation or more. A transition then, can be defined as a gradual, continuous process of change, in which the structural character of a society (or a complex sub-system of society) transforms (Rotmans *et al.* 2000). Transitions are not

uniform, and nor is the transition process deterministic: there are large differences in the scale of change and the period over which it occurs. Furthermore, although various actors carry a certain picture of the ultimate goal of the transition process in their minds, the form and content of the transition process are not predetermined. Transitions involve a range of possible development paths, whose direction, scale and speed can be influenced, but never entirely controlled, by individual actors (e.g. governmental policies). Transitions involve the emergence and development of new technologies as well as their diffusion into user domains and societal embedding. During the process of transition adaptation to, and learning from, new situations can take place, thereby influencing the overall transition process.

A transition is the result of developments in different domains. It can be described as a set of connected changes, which reinforce each other, even though they take place in several areas, such as technology, institutions, culture and belief systems. A transition can be regarded as a spiral that reinforces itself; there is multiple causality and co-evolution, caused by independent developments. Transitions are characterised by influencing and reinforcing economic, ecological, social cultural and institutional practices. Because transitions are multi-dimensional with different dynamic layers, their occurrence requires several developments to come together in several domains in the same timeframe. At the conceptual level we can distinguish four transition phases (Rotmans *et al.* 2001):

- 1 A *pre-development phase* of dynamic equilibrium where the status quo does not visibly change, but where different options and ideas for change are created and exchanged.
- 2 A *take-off phase* where the process of change gets under way because the state of the system begins to shift, due to the fact that actors are mobilised around promising perspectives.
- 3 A *breakthrough or acceleration phase* where visible structural changes take place through an accumulation of socio-cultural, economic, ecological and institutional changes that react to each other. During the acceleration phase, there are collective learning processes, diffusion and embedding processes.
- 4 A *stabilisation phase* where the speed of social change decreases and a new dynamic equilibrium is reached.

Different social processes come into play during the various phases. It is important to emphasise that fundamental changes do not necessarily occur in all the domains at the same time. Transitions also generally have periods of slow and of rapid development. A transition is a gradual, continuous process typically spanning at least one generation (approximately 25 years). Because the established equilibrium of the dominant regime involves stability and inertia, a transition also implies a fundamental change of assumptions and the introduction of new practices

and rules (Rotmans *et al.* 2001:17). Transitions can however be initiated or accelerated by unexpected or one-off events: for example a war, the oil crisis, or the BSE, swine fever, Foot and Mouth Disease and Avian Influenza crises in agriculture.

Co-evolutionary perspectives on innovation

Linear models of technological change and innovations assume innovation to be more or less independent of social forces and to be a predominantly technologically driven process. It assumes these changes proceed in a unidirectional and predetermined manner, starting with basic research and ending with the market adoption and dissemination. This then corresponds with the linear, three-stage, science-driven sequence of innovation from invention through innovation towards implementation. While this linear model of the innovation process provides an initial analytical framework that is applicable to some circumstances, there are distinct limitations to this approach (Moors 2000). First, innovations are not linear at all. While there are some logical priorities in the sequence of stages, there are numerous variations on the presumed sequence. Very often, an inventive research effort is a problem-solving response to some perceived need in the market. Accordingly, feedback and 'feedforward' cycles of information exchange are an important part of the innovation process. In addition, there are many shocks and unpredictable setbacks and surprises that can undermine the facile notion of a linear model of innovation, which show that innovation is, in fact, a highly iterative process. In other words, the linear model does not explain the dynamics of innovation, either in terms of the forces that drive and inspire innovation or those that constrain and frustrate it.

An additional shortcoming of linear models closely related to the first limitation, is the overly simplistic way in which the roles of groups of actors are allocated to specific and defined stages. Thus, the linear model suggest that it is only researchers who control the shape and content of research, that assembling and manufacturing belong purely to the domain of technicians, and that consumers and industry are the almost passive recipients of these processes. However, social studies of technology clearly demonstrate that the demands and concerns of end-users and interest groups are incorporated in the research agendas of firms (Rip and van de Velde 1997).

Taken together, these limitations provide sufficient grounds to argue that there is a clear need to reassess the traditional linear innovation model so that it includes iterative, interactive and complex dynamic process, that involve many factors and actors and which gives a central role to feedback and feedforward loops. The innovation process can then be regarded as an innovation journey with setbacks and changes in direction: as a 'trail of trials', continuously being influenced by the contexts that it encounters along its path (van de Ven *et al.* 1989; Rip and Schot 1999).

The existence of long term trends in technological change is widely recognised. Examples include the use of information technology in manufacturing and offices, the electrification of products and processes and, on the consumer side, the use of automobiles for transport. Economists, sociologists and historians have studied these regularities in technological change and have proposed various ways of explaining the ordering and structuring of technological change. Two concepts have been highly influential in the social studies of technology literature: the concept of technological regime introduced by Nelson and Winter (1977), and Dosi's concept of technological paradigm (Dosi 1982).

Nelson and Winter (1977) noted that the problem-solving activities of engineers were not fine-tuned to changes in cost and demand conditions, but were relatively stable, focused on particular problems and informed by certain notions (derived from an engineering background) of how to deal with these problems. They developed a theory of economic change, which included an evolutionary theory of technological change. This approach drew upon the biological metaphor of evolution to describe the innovation process. Thus, technological development was described as having two distinct elements: variation and selection.

Dosi (1982) introduced the idea of a technological paradigm, analogous to Kuhn's (1962) concept of a scientific paradigm. A technological paradigm consists of an exemplar (an artefact that is to be developed and improved) and a set of (search) heuristics, or engineering approaches, based on technicians' ideas and beliefs of where to go, what problems to solve, and what knowledge to draw upon.

The idea of a core technological framework that guides industrial research activities has gained wide acceptance in modern innovation theory. An advantage of this approach is its connection to existing engineering ideas and approaches, which traditional economic theories fail to achieve. But its ability to explain socio-technical change is limited, as it focuses excessively upon the cognitive aspects of problem-solving activities and places too little emphasis on the interplay between cognitive, economic and other social factors that force technological problem-solving in certain directions.

This interplay can be perceived as a co-evolutionary process of variation and selection, in which external selection pressures are anticipated by the innovator and incorporated into R&D programmes. The external selection environment is, in turn, shaped by the policies of the supplier and other actors who strive to promote (and control) a particular technology (for a more detailed discussion of the co-evolution of technology and society see Rip and Kemp 1998).

Engineering practices are embedded in larger technological regimes which not only consist of a set of opportunities but also provide a set of constraints, in the form of established practices, supplier-user relationships and consumption patterns (Hoogma *et al.* 2002:18-19). Accordingly, accounts of how technological regimes evolve need to encompass both the paradigmatic framework of engineers as well as broader social and economic influences. Rip and Kemp (1998) define a technological regime as

'the whole complex of scientific knowledge, engineering practices, production process technologies, product characteristics, skills and procedures, established user needs, regulatory requirements, institutions and infrastructures.'

A technological regime incorporates a cognitive and normative framework and a set of (functional) relationships between the technological components and the actors along the product chain. This framework forms the basis for individual and collective action and provides the context for technological and economic practices within a product chain, which predefine – both the problem-solving activities that engineers are likely to undertake and the strategic choices of companies.

The term regime is used in preference to paradigm or system because it refers to a set of rules. These rules not only take the form of a set of commands and requirements, but also include the roles of actors and established practices that are not easily displaced. They provide the search heuristics of engineers, product standards, manufacturing practices, standards of use, and the division of roles. These rules guide (but do not fix) the type of research activities that companies within a technological system are likely to undertake, the directions from which solutions will be chosen and the strategies of actors (manufacturers, suppliers, governments and users). Technological regimes are therefore a broader, socially embedded version, of technological paradigms. The nature of socio-technical change is in large part proscribed by the embeddedness of existing technologies in broader systems, in production practices and routines, consumption patterns, engineering and management belief systems and cultural values. This embeddedness creates economic, technological, cognitive and social opportunities for some new technologies and barriers for others (Hoogma *et al.* 2002:20). The notion of technological regime helps explain why most change is incremental aimed at optimising the existing regime rather than radically transforming it. It also helps to explain why so many promising new technologies remain on the shelf. This is especially true of systemic technologies that have long development times and that require changes in the selection environment (for example, in regulation, consumer preferences, infrastructure, and price structure). Radically new technologies require changes on both the supply and demand sides,

which usually take time and meet a lot of resistance, even within the organisation in which they are produced. Firms with a vested interest in old technologies will be more inclined to reformulate their existing products rather than to do something radically new, that may involve great risk. Both supply-side and demand-side changes are needed to introduce radically new technologies successfully. Such changes require new ideas, production and user practices, the development of complementary assets and institutional change at the level of organisations and markets (Rip and Kemp 1998).

Dynamics of technological transitions/regime-shifts

What is involved when changes in technological regimes occur? Obviously, each technological transition or regime shift is unique in its own way, but some general features can be observed. Studies of technological transitions have identified the following elements as key aspects of technological regime shifts (Kemp 1994; Hoogma *et al.* 2002).

- *Long periods of time.* It often takes one generation (20-30 years) for a new technological regime to replace an old one.
- *Deep interrelations between technological progress and the social/managerial context* in which they are put to use. Radically new technologies give rise to specific managerial challenges and new user-supplier relationships; they require and generate changes in the social fabric and often meet resistance from vested interests; they give rise to public debates over the efficacy and desirability of the new technology.
- *New technologies tend to involve 'systems' of related techniques;* the economics of the processes thus depend on the costs of particular inputs and availability of complementary technologies. Technical changes in such related areas may be of central importance to the viability of any new regime.
- *Perceptions and expectations* of a new technology are of considerable importance, including engineering ideas, management beliefs and expectations about the market potential, and, on the user side, perceptions of the technology. These beliefs and views about the new technology are highly subjective, and will differ across (professional and social) communities. They are in constant flux, and their evolution may provide a barrier or a catalyst to the development and acceptance of a particular technology.
- *The importance of specialised application in the early phase of technology development.* In the early phase of the development of a radically new technology there is usually little or no immediate economic advantage to be gained. At the same time incremental improvements to the existing technologies make it more difficult for the new one to compete and acquire a foothold in the market.

Accordingly, technological regime shifts, entail a number of structural changes at different levels. The emergence of a new technological regime implies the simultaneous evolution of these changes. This is a co-evolutionary process: technological options, user preferences and the necessary institutional changes are not given *ex-ante*, but need to be created and shaped. User demands are articulated and expressed in the process itself, in interaction with the available technological options. Producers learn new ways of viewing their own technology.

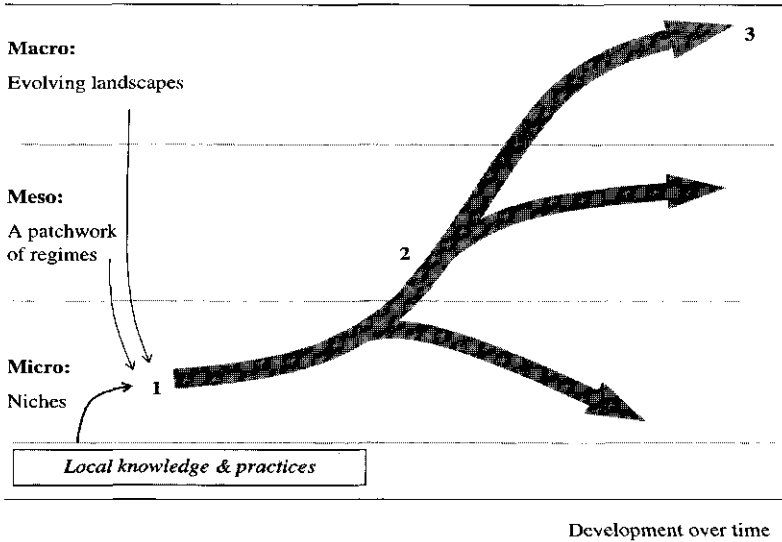
New technological regimes are not created *de novo*; they evolve through the actions and strategies of many different actors. The start of a regime shift can be very modest. Regime shifts often start at the periphery of the existing dominant technological regimes in small, isolated, application domains (so-called 'niches'), as specialised applications in early phases of technological development (Kemp *et al.* 1994). Only later does their wider applicability come to be appreciated.

Multi-level approaches to innovation

The concept of transition can be used at different levels of aggregation, such as companies, sectors, regions and countries. In terms of social organisation, roughly three different levels can be distinguished: the micro, meso and macro. The micro level comprises individual actors (e.g. in terms of agriculture, farmers and environmental groups). The meso level comprises networks, communities and organisations (e.g. agricultural production systems). The macro level comprises conglomerates of institutions and organisations (e.g. a nation). This division of micro, meso and macro levels corresponds closely with the classifications used by Rip and Kemp (1998) to describe changes in socio-technical systems, namely the division into niches, regimes, and socio-technical landscapes.

The socio-technical landscape encompasses material and immaterial elements at the macro level: material infrastructure, political culture and coalitions, social values, worldviews and paradigms, the macro economy, demography and the natural environment. The meso level of (socio-technical) regimes describes dominant practices, rules and shared assumptions. At the meso level are the interests, rules and beliefs that guide private actions and public policy – for the most part geared towards optimising rather than transforming systems. The niche level (micro level) describes individual actors and technologies and local practices. At this level, variations to, and deviations from, the status quo can occur, such as new techniques, alternative technologies and social practices. Figure 1 illustrates the multi-layered structure of socio-technical change.

Figure 1 General pattern of socio-technical change: 1 = Novelty creation; 2 = Novelty evolves, is taken up, may modify regime; 3 = Landscape is transformed (After Rip and Kemp 1998)



Often in the early period of socio-technical transition, the regime serves to inhibit change. Typically it will seek to improve existing technologies and use strategic actions to fight off new developments that challenge received wisdom and existing practices. Later on, however, when a new technological system comes into its own, the regime can have an enabling role. A characteristic of the macro level is that it responds to long-term trends and developments. However, this does not mean that individual actors (individual farmers, agricultural farms, local government) cannot be a catalyst for the transition process. Certain innovations in technology, behaviour, policy and institutions do break out of the niches of the micro level, if they stabilise into a promising design around which learning processes take place (Rotmans *et al.* 2001:20). For this to occur successfully, strategies and expectations, and a social network need to take form and become stabilised (Hoogma 2000). With the proliferation of the design comes a support basis – and, as a result, the momentum for take-off at the meso and macro levels. Alternatively, developments at the meso and macro levels (e.g. institutional changes, changes to regimes, belief changes) can also stimulate a take-off at the micro-level.

Regimes change as a result of internal conflict or external pressure, sometimes in response to bottom-up pressures from the micro level. Regimes may take a defensive approach, a reactive approach (seeking improvements within the present system) or an innovative approach by

contributing actively to a transition. Over the course of time they may adopt all three. The multilevel aspect of transitions implies that change only occurs if developments at one level gel with those in other domains. But there must also be interaction between developments at the micro, meso and macro levels if the transition process is to occur (Rotmans *et al.* 2001:20). The next section describes in more detail the mechanisms and patterns underlying these transition processes.

Socio-technical dynamics of innovation processes: patterns and mechanisms

The previous section explained what transition processes are. In this section we address the questions of how transitions come about and whether we can distinguish particular patterns and mechanisms in transition processes. The focus on patterns and mechanisms, rather than on particular technologies, is needed because sectoral innovations (for instance, in agriculture) are not related to a single technology that is in need of replacement or alteration, but to a range of technologies, that are interconnected which each other and with the social system in which they are put to use. For example, changes in the agricultural sector are related to a broad range of influences, including the availability of energy and other resources, what and how people eat and, how and where that food is processed, distributed and marketed. In addition to this view which takes into account the whole supply and consumption chain it must also be borne in mind that agriculture has to compete with other policy concerns, such as economic, environmental and spatial planning.

Arentsen *et al.* (2002) provide a useful conceptual model of the major stages in the transition of socio-technical regimes, which seeks to take these broader features into account. They identify three main phases of transition within socio-technical regimes:

- 1 *Dynamic stability.* This stage represents a congruent dynamics in and amongst all of the dimensions of the regime. The regime is in a stage of dynamic stability because the ongoing dynamics in all dimensions are in accord with each other and mutually supportive in their development. The knowledge base of the regime produces new technologies incrementally, improving incumbent technologies so that they smoothly integrate into the regime. Changes and developments in the regime increase its dynamic stability.
- 2 *Friction.* This stage represents incongruent dynamics among the dimensions of the regime that create internal tensions. There are many causes of such frictions: for instance an incongruence between the dominant form and the dominant function of a technology. By technological form we mean the design and construction of artefacts, their components and their integrated performances. Technological

function refers to the meaning of technology to its users: as a 'tool' that must satisfy certain physical, social, economic or cultural needs. Form and function can be either balanced or unbalanced. A change in the policy setting, economic environment, or in the knowledge base may cause friction within the regime.

- 3 *Dynamic instability.* In this stage, the ongoing dynamics within different dimensions takes on diverse and sometimes divergent courses. The regime enters a state of flux, and the direction of future developments becomes unclear. The functional need for technology remains but it is unclear how the other dimensions will shift in order to satisfy functional needs. The regime may develop into a new stage of dynamic stability. At this point a transition in the regime can be said to have occurred.

Who or what are the agents of change involved in transforming regimes? Actors and actor network configurations play an important role. All actors operating in the context of a socio-technical regime are part of various networks (e.g. research networks, user groups, suppliers, producer networks, financial networks and social groupings) and their everyday decisions and activities mould and shape socio-technical change without them necessarily being aware of this. They all act in a seemingly uncoordinated way, motivated and guided by the economic logic of the market, the political logic of the bureaucracy or the scientific logic of the laboratory. A variety of incentives, past experiences and future expectations, motivates and influences these actors in their decisions and activities which, in turn, almost invisibly mould and shape socio-technical change. Yet these actors are not merely passively influenced by external forces. They also try to shape and influence the outside world, according to their own interests. They develop and maintain networks with other organisations or actors in order to increase access to, and control over, the resources required to achieve their specific goals. They develop coalitions and strategic alliances to maintain and improve their position vis-à-vis resources and the market. It is this complex web of actions and interactions that fuels socio-technical changes in regimes. In order to understand the stability and dynamics of regimes it is important to distinguish between the attributes of actors and those of interactions between actors.

Socio-technical developments are always context bound, but it is possible to trace patterns, regularities and major drivers within the transition process. Modulation options can be derived from the co-evolutionary, multi-level perspective on socio-technical change. The concept of modulation options was initially expounded in Rip and Kemp (1998), and subsequently applied by Geels and Kemp (2000). In this context actor-oriented modulation describes the process of influencing the existing

ideas and perceptions of actors, through providing new points of reference for innovation and technical change (e.g. strategic communication of new ideas about desired future developments). In the following paragraphs we describe several specific features of transition processes that have a potential to act as entrance points for modulation.

One modulation option, that takes technology as its point of reference is the 'promise-requirement' cycle of perceptions and expectations. This modulation option makes explicit the interaction between variety and selection and actively tries to anticipate the creation and selection of the desirable forms of technology. One way of organising this kind of modulation is to explicitly identify the functional requirements that new technologies are assumed to address in the future and to organise and manage innovation in response to these findings.

Cross-technical linkages and hybrid forms occur when one emergent form of technology is transferred to another context. The importance of such linkages is clearly illustrated by the example of the transition from horse-based transportation to cars in the early 20th century (see Moors and Geels 2001). The development of vehicles with internal combustion engines was built upon the knowledge and experiences gained from the bicycle, gas-engine and horse-drawn coach transport regimes. The later introduction of the electric starter provides an interesting example of a positive cross-technical influence: one that accelerated the technological trajectory of gasoline cars by borrowing an element (batteries and high voltage ignition) from electric vehicle technology. Incidentally the study of electric vehicles (*ibid.*) showed a high level of cross-fertilisation between military technology knowledge and the development of the electric vehicle. Many hybrid forms emerged, combining the knowledge and competencies of the dominant internal combustion transport regime with the potential emerging from new electric vehicle regime. Further examples of cross-technical influences and hybrid forms in technological developments in industrial metals production can be found in Moors (2000).

Accordingly, hybrid forms may be an important transitional element, which helps society to move to achieve a transition towards a new regime. The word 'transitional' does not just mean temporary. Hybrid forms may have a 'pathway' function and can catalyse complex, differentiated interactions which in turn generate an accumulation of niche developments. These new technical developments compete with the old technologies via the same niche accumulation mechanisms (i.e. alignment, cross technical influences and hybrid forms), and in the end may destabilise the old regime, opening it up for new technico-institutional designs of development. External factors also significantly influence these transitions. Changes in the socio-technical landscape (e.g. changes in prices, values, belief systems, politics or trade) open up new spaces for

innovation and set overall directions for a technological regime. Increasing awareness (amongst farmers, consumers, policy makers and environmentalists) of the unsustainability of current agricultural practices is leading to a renewed interest, amongst these different actors, in 'alternative' agricultural practices. As these alternatives gain momentum new possibilities emerge, which in turn generate new opportunities.

An important feature of agricultural systems, which sets them apart from other technological regimes is the very high degree of heterogeneity that exists within them. Despite fifty years of modernisation which has, amongst other things promoted uniform solutions to the problems faced by farmers, there still exists a great variety of farming styles, strategies and mixes, even within any given region (Van der Ploeg 2003). In addition agriculture remains one of the few economic activities in which resources and decision making capabilities ('the means of production') are widely distributed amongst, mostly, family owned units (as opposed to being concentrated in relatively few companies). Both these factors facilitate the opportunities for the evolution of multiple and decentralised learning processes. Local agro-ecological and cultural circumstances can necessitate and/or act as a catalyst for engendering unique responses and developments. In some instances these may only be appropriate to the locations where they were developed, but in other examples they may well prove to be transferable. Such variety provides an important resource for achieving evolutionary change and has the potential to be strategically exploited for broader regime shifts and transition processes (Kemp and Moors 2002).

In summary, transition processes can be regarded as gradual and multi-faceted processes in which cross-technical influences, hybrid forms and the identification, and active stimulation, of pathway technologies all play an important role. Furthermore, the socio-technical regime is shaped by wider, external, developments in the socio-technical landscape, which create opportunities for change and define directions for development. Agriculture exhibits a great heterogeneity in terms of its practices and user needs and this is a potentially valuable resource for developing socio-technological regimes that are more closely aligned with the principles of sustainability.

The mechanisms of change and modulation options provide some clues as to how we might work towards an agricultural regime shift that is more closely aligned to sustainability criteria. This could be achieved through the use of strategic niche management. The next section presents the main characteristics of strategic niche management.

Strategic Niche Management

Arguments concerning the unsustainable character of modern agricultural practices are well rehearsed. Adverse impacts of modern day agricultural systems include water and soil pollution; nuisance from noise and odour; animal welfare issues; growing consumer concerns over the safety of intensively produced food; the growing distance that food travels from farm-gate to fork; overuse of land for growing animal feed; mad cow disease and other epidemics, destruction of valued habitats and landscapes through overproduction; and the repression of possibilities for small-scale farmers to build their own agricultural communities. At the same time, as part of a quest for sustainable agriculture, new and interesting ideas about alternative technological, organisational and social solutions to modern agriculture systems are emerging. These have mostly been developed by small groups of farmers, developing novelties and prototypes and experimenting with promising alternatives. In practice, many farmers already practice various forms of 'downgrading', (i.e. through low-external input or 'economical' farming) in order to adapt their particular farm better to the prevailing ecological and/or economic situations in which they operate. Downgrading is also adopted as a strategy when farmers try to adapt their farming business to the peculiarities of the products that they produce, or to their preferred farming strategies. In situ experimentation with novelties and local knowledge play a crucial role here. The inventiveness of farmers gives rise to an impressive range of, sometimes astonishing, novelties (e.g. Mango 2002; Wiskerke 1997; Wiskerke *et al.* 2003). However, within the context of the prevailing, dominant agricultural regime, many of these practices remain isolated hidden novelties. These new technologies and associated agricultural practices have not (yet) led to larger changes in the ways in which agriculture is organised and governed. Somehow the adoption and diffusion of these initiatives does not receive adequate support and does not percolate up to the guiding and governing organisations. Strategic Niche Management can provide a management tool to address this deficiency.

Strategic Niche Management (SNM) is about the creation, development and controlled break-down of niches for promising new technologies and concepts. This is achieved through setting up experiments which aim to demonstrate their desirability (for example in terms of sustainability), ways in which they can be improved, and to enhance their rate of diffusion (Weber *et al.* 1999; Hoogma *et al.* 2002). SNM should be regarded as a tool for building niches for novelties, mainly through smart experimentation. SNM provides an opportunity to explore and learn, in a quasi-controlled manner, about the practicality of an innovation outside the R&D setting in which it was initially developed. When novelties come out of their R&D stage they can be seen as fluid options, which embody a

number of assumptions about how the technology can be best used and under which conditions. At this stage the design of a technology and the assumptions about how it will be used are in need of further testing. Such testing will result in a better specification of the design itself, as well as identifying user needs and conditions.

Many innovation studies have pointed out that appropriate testing requires the active inclusion of users, policy-makers, researchers and, in some cases, representatives of the general public. They also argue that testing should be viewed as a learning process in which the potential of a new technology is articulated and accepted, amended or rejected. These potentials will include design features, system changes, user characteristics, values associated with its use and policy preconditions.

Accordingly, testing is a process of articulating, specifying and sharing a set of expectations and visions of the potential of a new technology. This process can also generate the emergence of a strong network of actors willing to invest in, and carry a new technology forward. These processes should ultimately lead to the development of better technologies and, possibly, a much smoother diffusion process, since a better fit is achieved between the technology and its social environment (Weber *et al.* 1999). Such experimentation can generate insights into user requirements, desirable design modifications, support measures and likely environmental effects. Such experiments also represent a first step towards the development of a niche for new developments.

A niche can be defined as 'a specific application domain (habitat) where actors are prepared to work with specific functionalities, accept teething problems, higher costs, and are willing to invest in improvements of a new technology and the development of a new market' (Hoogma *et al.* 2002). Developing a niche involves exposing the innovation, on a step-by-step basis, to real-world conditions. It involves a second stage of interaction with users, that of learning about constraints and requirements. This occurs in an environment that is less isolated than the experimental one. If successful, a novelty might move from the original niche to follow-up niches resulting in a process of niche branching*. The first niche often provides the resources to sustain the innovation; the time, capabilities, knowledge, and finance for a network to emerge that is able

* Rip (1995:418) described the process of *niche branching* as follows: 'Technological change is not a continuous process along dimensions of increasing functionality. It is more like a patchwork quilt or, if one prefers, a different metaphor, the way yeast cells grow. Developments branch off in different directions, cross-connections and interactions occur, and niches, that is limited and relatively easy or advantageous domains of application and further development, strongly determine what steps can be taken productively. The eventual shape of a technology, its usage and the way it is embedded in society can be very different after 5, 10 or more years than it looked at the beginning.'

to produce and use the new technology. From this first niche, a number of new niches can be developed. This process of niche cumulation and niche branching includes the emergence of new application domains and the creation of a 'bandwagon' effect (that is a wider diffusion) through replication of the niche elsewhere (Hoogma *et al.* 2002:24). Eventually novelties may come to compete head-on with the dominant technological regime within its own markets.

Smart experimentation and subsequent niche formation do not automatically lead to regime shifts or radical change. They can lead, first, to a long process of niche proliferation – that is, a process of continued protection. In some cases market niches may develop without further protection and regular market transactions will prevail. More rarely the proliferation, over a number of years, of technological niches (protected spaces) and market niches may result in a regime shift, i.e. a shift in the technological foundation and in agricultural patterns. Such a broad change cannot be brought about by niche development only, or by SNM. If it takes place, it will be the result of a combination of successful SNM, niche development and a set of other factors. These might include the exhaustion of perceived technological opportunities within the dominant regime, a dramatic change in government policies and/or the emergence of a new set of values that incorporate sustainability. SNM is a crucial aspect of this complex process, setting in motion a transition path that nurtures sustainable technologies and allows them to grow (Hoogma *et al.* 2002).

Successful niche development: quality of learning and institutional embedding

Hoogma *et al.* (2002) identify two measures for evaluating the success of early niche development: quality of learning and quality of institutional embedding. Learning refers to a range of processes through which actors articulate relevant technology, markets and other properties. It is called a learning process because the outcomes are not known beforehand, but have to be worked through, by the actors themselves. Learning involves a number of aspects (Hoogma *et al.* 2002:28):

- *Technical development and infrastructure*, which includes learning about design specifications, required complementary technology and infrastructure;
- *Development of user context*, which includes learning about user characteristics, their requirements and the meanings users attach to a new technology and the barriers they encounter in their use;
- *Societal and environmental impact*, which entails learning about the health, safety, cultural and environmental aspects of a new technology;
- *Industrial development*, which involves learning about the production and maintenance network needed to achieve a broader diffusion;

- *Government policy and regulatory framework*, which involves learning about institutional structures and legislation, the government's role in the introduction process, and possible incentives to be provided by governments to stimulate adoptions.

Learning can occur at a number of levels. It may be limited to first order learning. That is when various actors within the niche, learn about how to improve the design to make it more acceptable to users and about ways of creating a set of policy incentives that will accommodate or encourage adoption. However, for niche developments to lead to a regime shift, a different kind of learning process is needed, second order learning. Here concepts about technology, user demands and regulations are not only tested, but also questioned and explored. Opportunities emerge for co-evolutionary dynamics, that is the mutual articulation and interaction of technological choices, demand and possible regulatory options. Co-evolutionary learning also allows for, what Wynne (1995) calls 'collective value learning', that is clarifying and relating the various values of producers (designers), users and other involved parties, such as governments. Thus successful niche development involves first order learning in a wide array of areas (see above), as well as the occurrence of second order learning.

The emergence of a new socio-technical regime will change the selection environment for innovation. Earlier processes of niche development will proceed this change, thus paving the way for broader change through a process of institutional embedding: Three crucial aspects of institutional embedding can be identified:

- Institutional embedding gives rise to complementary technologies and the necessary infrastructures, a necessary factor for increasing adoption in later diffusion phases;
- Institutional embedding produces widely shared, credible (i.e. supported by facts and demonstrated successes) and specific expectations;
- Institutional embedding enlists a broad array of actors aligned in support of the new regime. This network includes producers, users and third parties, such as government agencies and investors.

Alignment describes a situation in which the actors have developed a stable set of relationships and can readily mobilise additional resources from within their own organisations, because the network has come to be regarded as an important, credible and strategic operation. In such situations, so called 'macro-actors' (Rip 1995:426-427) often emerge, who have a specific responsibility for developing and maintaining harmony and a sense of common purpose within this alignment. Accordingly, successful niche development assumes the development of

complementary technologies, more robust expectations and a broad and strongly aligned network (Hoogma *et al.* 2002:28-29).

Market niches and technological niches

Niches can be market niches, in which a novel technology has specific (promised) advantages over the established technology. These advantages are quickly recognised by producers and users and the technologies generally emerge in a bottom up manner. Other promising new technologies may emerge in top-down fashion, in proto-market or technological niches.

Technological niches may promise specific advantages but these are unsubstantiated or only partially recognised or accepted by some actors within the network. Often, the activities associated with developing this kind of niche will be geared towards identifying and testing assumptions about these advantages. Technological niches come about through experiments, pilot and demonstration projects. Four distinct possible outcomes of SNM (and the further development of niches), can be distinguished for technological niche development:

- 1 The technological niche remains as such. Follow-up experiments are set up to further test the applicability, relevance or desirability of the innovation. This might involve branching to new application domains or replication in similar domains. Technological niche gestation might lead to expansion and scaling-up of the niche in a context that was not originally anticipated.
- 2 The technological niche becomes a market niche. New experiments are no longer necessary as users start to recognise the advantages of the novel technology and suppliers are willing to invest in production on a small scale.
- 3 The market niche expands and branches out in new directions, leading to the emergence of new market niches.
- 4 The extinction of the technological or market niche. The novel technology fails to attract further support and becomes (again) a (this time, less-promising) R&D option. Niche extinction does not necessarily imply that investments are lost. Spill over effects, in terms of network development, technical learning, and improved reputations are some of the benefits that can emerge from a 'failed niche'. Learning that a certain technology development is not desirable is also an important part of SNM.

To sum up, SNM should be regarded as a management tool, which can contribute to successful niche creation for novelties. Its main benefits lie in overcoming barriers to diffusion by exploiting niche dynamics. The SNM approach puts learning processes to the fore, with the result that it is difficult to be specific about outcomes beforehand. Put another way, SNM is about changing the processes of change: introduction processes are

designed in a different way. The long-term goal of SNM policies is to create new rules and routines (or what neo-institutional economists would call 'institutions'). These facilitate the earlier and more frequent anticipation of impacts, user requirements and related technical choices. They also foster processes that are specifically designed to stimulate learning and reflexivity, and create space for experimentation. In the long run, the ability to deal with difficult and complex processes will become more widespread.

This book focuses on various agricultural niches, where favourable (but mutually contrasting) conditions, make it possible to go beyond the impasse that often exists between novelty production, on the one hand, and the dominant agricultural regime, on the other. Such situations permit Strategic Niche Management. This book draws upon examples of interesting novelties, illustrating how scientific expertise and institutional design capacity can be combined and contribute to improved farming models (regimes). In all of these examples these models are based upon the principles of low external input farming. They embody a well-thought through and structured move towards less intensive and more sustainable farming practices.

Transition management

Whereas SNM can be understood as a tool or approach to set a transition path into motion, transition management can be viewed as a comprehensive framework for achieving a coherent and integrated move towards a desired future state (e.g. sustainable agriculture). Transition management encompasses multi-dimensional change of a socio-technical regime. The final section of this chapter addresses questions of whether, and to what extent, transition processes can be consciously managed.

Experience shows that a command-and-control approach is not a feasible option for addressing the problems of complex socio-technical systems, such as the current agricultural regime. The non-malleability of technology means that governments cannot simply 'call up' desirable technologies through legislation. Incentives and constraints (including regulation) do have effects (in proportion to the level at which they are introduced), but governments cannot control the level of effectiveness or timing of these. Thus, there is a dilemma of control, identified by Collingridge (1980) who noticed that governments have the greatest influence over technological choices when they are in their infancy and when least is known about their impacts and desirability. When the technology becomes more fully developed and more widely used, it becomes more difficult to control it, because of vested interests and high adjustment costs. This should not be taken to mean that technology

becomes out of control, but rather that the dynamics of control do not always lead to universally acceptable outcomes (Rip and Kemp 1998). Accordingly, a different type of approach is needed, which we might call modulation. Modulation policies are oriented at the dynamics, structures, strategic games and learning. They imply new roles for governments: those of 'alignment actor', matchmaker and facilitator of change (Rip and Kemp 1998; Kemp 2000). This in turn leads to a different set of policy recommendations. A modulation strategy does not imply abandoning traditional policies of regulation and taxation but places more emphasis upon long-term transition goals and regime shifts (system innovations). Within a modulation strategy policy instruments should be fine-tuned to the context in which they are applied. Different instruments are effective at different phases of the transition process. In the pre-development phase, policy should stimulate variation and societal discussions about sustainable agriculture. Once the more attractive solutions and configurations have been identified, it should stimulate investments and the integration of new technologies within existing regimes (via cross-technical linkages and hybrid forms). Public planning and system management designed to control the side effects of new niches and regimes are important instruments later in the transition phases. In general, there is a need for both generic and technology-specific policies (Kemp 2000; Arentsen *et al.* 2002; Kemp and Moors 2001).

Examples of modulation policies have been described under the label of transition management in Rotmans *et al.* (2000, 2001). Kemp and Moors (2001) provide a number of suggestions of strategies for transition management, which we discuss below:

- *Engagement in the use of social experiments and creation of niches for promising technologies (Strategic Niche Management).* At the early phase of development, new technologies need protection from the selection environment. Without protection new technologies face difficulties in coming into their own. However, this protection should be partial, temporary and phased out. This fosters interactive learning and institutional adaptation which are necessary for pushing the transition process forward. Government policy can assist with this process. By focussing on local opportunities afforded by special circumstances a transition path may be created in a bottom-up, non-disruptive manner. Particular support should be provided to 'pathway technologies', those technologies that help to bridge the gap between the current regime and a new one, thereby helping to avoid lock-in. (see Hoogma *et al.* 2002).
- *Stimulation of pathway technologies.* How can such pathway technologies be stimulated? It is important to explore a wide range of new agricultural systems as they may generate a diverse range of benefits

and because, as a general principle, society should not place all its eggs in one basket. The need for stimulation and the forms that it takes should be regularly assessed, and policies should be flexible. To increase the chance of a transition occurring and to make sure that the path chosen is the best one, different paths should be explored, together with the possibilities for positive cross-linkages, cross-influences and cumulative effects. .

- *Focus on routes of niche accumulation that may lead to regime changes.* Transition cannot be guided and managed unless there is a transition path. However there is not just one path but many possible paths of which it is impossible beforehand to tell which one is the best (if there is a best path at all). There is a need to identify all possible paths and to explore these. By creating a little bit of irreversibility in the desired direction (e.g. towards downgrading in agricultural practices) a new path or trail may be created. To identify or create this 'desirable' trail, it is necessary to evaluate the present agricultural regime and the possibilities that exist to shift it towards more sustainable directions. This implies the need to identify opportunities to influence niche branching. Active stimulation of the development of hybrid forms and pathway technologies act as interludes between the old and new regime and could facilitate transitions to a new agricultural regime. One should consider interrelationships between different developments. Cross-technical influences may provide a momentum for development. Thus, the focus should be on experimenting with a wide range of niche agricultural technologies, which in the long-term could serve as stepping stones for a new agricultural regime. The experiments should be more than just demonstration projects. They should be set up in such a way that suppliers and users both learn about the new possibilities. Basic assumptions and existing expectations should be tested through second order learning.
- *Modulation of 'promise-requirement cycles' of perceptions and expectations.* New technologies have been characterised as 'hopeful monstrosities' (Mokyr 1990). They hold promise, but are still under -developed in terms of user requirements. The requirements themselves may not yet be clear or be in state of flux. This calls for the need to stimulate 'promise-requirement' cycles and to mobilise the resources necessary to build a forceful agenda (for development work in the technological niches) in which general, societal, interests strengthen and support the private and short-term interests of individual actors. Promise-requirement cycles may give rise to new markets, opening up the possibilities for wider (external) changes.

Transition management as an integrative framework

The above actions should be pursued as part of an overall transition endeavour and not as isolated actions. They are best undertaken as part of a structured 'total transition' programme with discrete rounds of development in which progress is assessed and goals and instruments are evaluated (and adjusted) through the use of a transition agenda. Transition management then becomes a collective, co-operative effort to work towards a transition in a step-wise manner. Three key elements of transition management are:

- 1 The establishment of a transition goal, based on visions of sustainability (e.g. downgrading).
- 2 The use of societal experiments with technological options that fit with this vision.
- 3 The use of development rounds in which policies and transition goals are reassessed and redefined.

Transition management involves the use of a wide range of policies, the timing of which needs to be gauged to the particular circumstances of transition phases and external developments. It does not offer a step model to get to state Y via steps X1 to Xn. Some policy interventions, such as the exploration of many solutions in the pre-development stage, and policies towards system integration in the take-off stage, are stage specific. Others, such as the periodic reassessment of goals, visions and policies, are recurrent. Other policies, such as the internalisation of external costs, and support of science and technological research for sustainable agriculture should be continual and ongoing. Transition management differs from the more traditional approach of planning and implementation. It does not operate on the basis of a blueprint, but on the basis of a set of goals (or quality images). These goals are not fixed and the policies to further the goals are constantly assessed, and periodically adjusted, in development rounds. This creates some flexibility while maintaining an overall sense of direction. Through its focus on long-term ambitions and its attention to dynamics transitional management aims to overcome the conflict between long-term ambition and short-term concerns. Learning, maintaining variety and institutional change are important policy aims. Transition management does not only consist of instruments, but is also about ways of interacting and the mode of governance which, in the case of agriculture, has to develop new technico-institutional designs. It is important that outsiders should be involved in the transition process, that there should be commitment to change and clear objectives and that the transition endeavour should be institutionalised. All this does not provide a guarantee of success, but it does increase the chances of a transition towards a new, downgraded, agricultural regime actually occurring.

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3 Novelty as Redefinition of Farm Boundaries

Flaminia Ventura and Pierluigi Milone

Introduction

During the past few years a range of new factors have emerged that are beginning to reshape agriculture, making it more responsive to new social needs and priorities. These factors are modifying the institutional context in which farms operate. They may be summarised as follows:

- the introduction of the concept of sustainability into economic activities;
- the limits of returns to scale in agricultural enterprises, due to natural resource constraints which lead to an increase in costs;
- the need to maintain high labour incomes in developed countries, for reasons of social equity

Together these factors result, in post-industrial countries, in a crisis in the paradigm of mass production and the technological regimes connected with it. The New European Agriculture, that is unfolding as a response to this crisis (van der Ploeg *et al.* 2002), aims at guaranteeing multifunctional production processes that combine productivity with environmental sustainability, and secure the reproduction of natural and cultural resources. This has to be achieved within an international context in which trade liberalisation and reductions of subsidies dominate the agenda. Technological progress that aims to increase agricultural productivity no longer provides acceptable, or even useful answers, from an economic, political, or environmental viewpoint.

Thus, a quiet revolution is occurring in agriculture that entails two closely connected trends:

- The rediscovery of the possibility to differentiate agricultural products on the basis of their tangible and intangible characteristics, made possible by growing consumer interest in a wider range of qualitative specifications regarding food products;
- The growing attention paid to resources that are used in agricultural production and particularly to those resulting joint products that are not amenable to market exchange as they cannot be reproduced

outside of farming except at high production and transaction costs. Examples include biodiversity, local 'know-how' and traditions, soil fertility, and the protection of landscapes, soils and watersheds.

These trends emphasise the need for a new economic model for agriculture that, in turn, needs a new institutional and technological regime capable of addressing a range of issues that are of importance to European society, particularly those of employment, environment, and consumer confidence.

This model corresponds closely to that of flexible specialisation (Piore and Sabel 1984), which is based on the rediscovery of (1) the distribution of production processes over more than one unit, (2) the artisanal nature of production processes and (3) the utilisation of human skills and specific knowledge. In this model the expertise of the individual operators (farmers, food processors) plays a key role, allowing them the possibility to reassert choice and authority over the scale and orientation of their enterprises.

Neo-institutionalism and the paradigm of flexible specialisation

Two elements can be identified as contributing to the success of artisanal farming styles. The first consists of reducing or minimising the need for external inputs and minimising the costs (including transaction costs) of inputs that cannot be replaced. The second is that of diversifying farm activities, or finding a way to increase the value of the artisanal component of farm produce.

In the first case this leads to a multi-product farm (Teece 1982), where the on-farm labour, skills and know-how become central resources used to (re) produce resources that would otherwise have to be purchased. In the second case we have a process of product differentiation, competitively *repositioning* the farm's produce.

In economic terms these farms are pursuing economies of scope¹ (Panzar and Willing 1982). They do so through two distinct strategies:

- the reduction of production costs, through utilising the same factor in several production processes (specifically those factors where the farmer controls the property rights, i.e. land and labour);
- external economies² arising from synergies that are created within a single territory, or through a network of operators (economic and/or institutional) which permit the product to be valorised, often through the use of formal quality specifications, which tie the product to a specific geographical area or production process (Brunori and Rossi, 2000).

In the first case the economies of scope are achieved within the farm, through a reorganisation towards multiple production. The lower the cost

of organising and co-ordinating the factors of production and governing the production processes connected with them, the more efficient the enterprises become. For example, in family-run farms, the costs of governing labour resources can be extremely low due to mechanisms of reciprocity that exist within families.

In the second case the economies of scope depend on the institutional context and its capacity to create convergence between different interests and thereby reduce the governance costs associated with the bargaining processes. The existence of local systems, characterised by production processes that are strongly embedded within local culture and ecology allow farms to achieve economies of scope, without an increase in the uncertainty associated with market exchange mechanisms.

The nature (and potential) of economies of scope can best be understood through the concept of transaction costs (Teece 1980). If all transactions were without costs, it would make little or no difference to firms whether factors of production were purchased on the market or produced internally. However, the costs associated with transactions are often significant, particularly when the factors of production are very specific, and this can influence a firm's preference as to whether to buy in or produce internally.

The centrality of transaction costs to understanding economic decision making was developed by Williamson (1981; 1996). He defined transactions as modes of realising exchange that are characterised by:

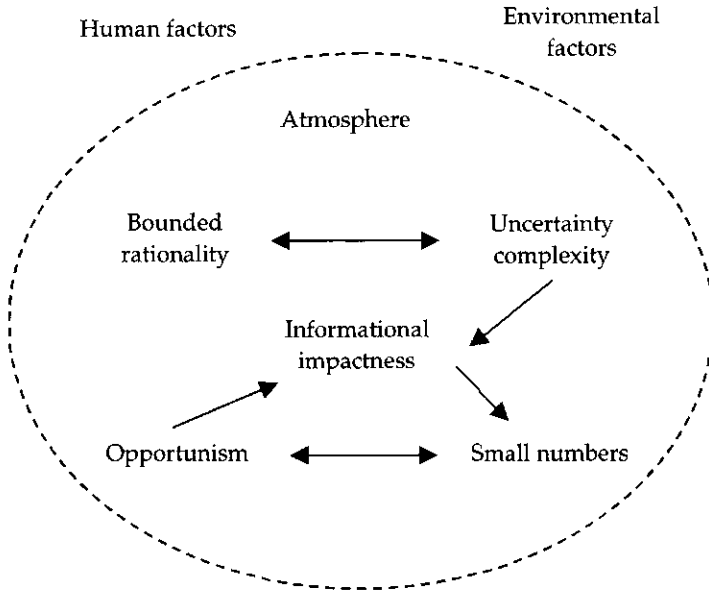
- the object of the exchange;
- the parties to the exchange;
- the set of rules and actions, called the governance structure, that make the exchange possible by connecting the economic and organisational aspects with contractual obligations.

This analysis can be further developed by regarding transactions as consisting of hard (or immutable) features and soft ones. The hard features consist of the object of and parties to (or subjects of) the exchange, whereas the soft part describes the ways in which the transaction is carried out. The theory of transaction costs differs from traditional analysis of exchange as it moves the focus of analysis from the hard to the soft part. Williamson's transaction cost theory examines the causes of transaction costs and the choice that exists between making a transaction on the market or within a firm. This is known as the Williamson criterion or rule (Williamson 1975; 1985).

Figure 1 shows the context in which such choices are made. The context includes both human factors (the preferences and limitations of individual actors) as well as environmental ones. Opportunistic behaviour (or the anticipation of it), bounded rationality, uncertainty, complexity and limited market size all play an important role in determining the extent to

which full information (a necessary precondition for the functioning of a perfect market) will be available. In different market situations these interacting influences will play different roles in determining this.

Figure 1 Human and environmental factors responsible for transaction costs



Williamson sought to address the relative importance of the factors that influence the choice between market transactions and internal ones. In so doing he developed the concept of the *specificity of resources* required to carry out transactions (Williamson 1981). Specific resources are those that are incorporated within firms and include land, buildings, machinery tools and knowledge. In general, transactions that require a high level of resource-specificity will involve higher transaction costs. Thus, a producer with a very specific asset base and/or product range is likely to have only a limited market. A buyer with specific demands for product criteria is likely to find only a few suppliers. The greater the reliance of either party on specific resources, the more they will prefer to adopt long-term contracts as opposed to bargaining on the open market. The specificity of the resources required to realise transactions is related to location, human resources and physical assets. The first of these is connected with the lower costs involved in entering into transactions with a locally based seller or buyer. The second relates to the need to learn certain productive processes, acquire skills and/or develop teamwork. Finally, the third concerns the set of idiosyncratic physical investments, which may be related to future as well as current transactions (e.g. promotional expenses).

In neo-institutional theory, the firm is conceived of as an organisation where actors are characterised by a limited rationality and acts under conditions of uncertainty and with an opportunistic behaviour. Within this theory the objective of the firm is to reduce this uncertainty, through developing contractual relationships that will enable better organisation of the different functions of the firm in order to enhance profitability.

Thus, according to neo-institutional theory, the firm is a governance structure that organises production factors and market exchange mechanisms that constitute its 'functional space'. This functional space consists not only of the classical production and market spaces, but also includes a third category of relations called support space (Ratti 1998). This is defined as the group of relationships that are situated outside the market.³

The entrepreneur's choices are made within the constraints of limited (bounded) rationality, as described by Simon (1957) who identifies limited rationality as behaviour that is rational in intent but only partly so in reality, as there are limits on human knowledge, foresight technical skills and time.

Thus in the real world limited rationality and uncertainty⁴ make it practically impossible to arrive at complete contracts. Indeed, the very process of analysing an almost infinite number of choices and combinations of choices would in itself lead to unrealistically high contractual costs, making it uneconomical to enter into such contracts. This is compounded by uncertainty, about future changes, in the context and in the behaviour of other traders. On the basis of this hypothesis Tirole (1988) conceptually redefines the firm as a long-term organisational structure that incorporates production factors and exchange activities between actors exercising their property rights through incomplete contracts. Because of the incomplete nature of the contracts subsequent renegotiations are necessary. In consequence, the contractual positions of the actors may shift, thus increasing the uncertainty surrounding the outcome of future negotiations.

Over time firms seek to reduce uncertainty through reducing the transaction costs connected with contractual incompleteness. These mechanisms differ and are highly dependent on the institutional context in which the firm operates. Reputation, authority, loyalty and work ethics may all play a role here. A high level of trust between citizens and between citizens and institutions can drastically reduce transaction costs. The evident lack of such trust in many modern societies creates the need for increasingly complex and costly controls that may even make it impossible to carry out some types of production and exchange activities (North 1984; 1990).

The process of innovation also plays an influential role within these incomplete negotiations:

- on the one hand, innovations contribute to the uncertainty and incompleteness of negotiations as it is difficult to anticipate developments that may occur after the negotiations are concluded (Grossman and Hart 1986);
- on the other hand, the contractual incompleteness may act as a deterrent to innovation, as it may lead to a position of disadvantage in future renegotiations.

The process of innovation is characterised by a high level of specific and tacit knowledge and by the ability to make appropriate use of the results of learning processes. According to Dosi (1990), the innovative process comes about as a result of interactions between firms, who recognise the opportunity to achieve technical progress and market advantage. This process is endogenous to the firm that is constantly innovating.

According to Teece (1982), transaction costs also explain why firms internalise processes of innovation. Apart from the specificity of knowledge required to do any job, the incremental nature of innovation, and the strategic importance of developing the capacity to learn, make it impractical to contract innovation out to the market, without incurring high transaction costs. As a result of internalising the process of innovation, firms are also able to re-deploy and re-use specific material assets.

In agriculture resources are generally highly specific. Each area has specific characteristics of soil, relief, climate and vegetation as well as management process that have evolved in order to best manage the local natural resource base. This process of contextualisation has in turn entailed and required the development of specific knowledge about the use and management of territorially specific factors. In areas where natural resources have a strong specificity, or where local traditions influence (either formally or informally) specific production processes, farms have tended to pursue economies of scope, as the pursuit of economies of scale would entail excessive transaction costs. One result of this has been the progressive marginalisation of such areas. The innovations of the dominant technological and institutional regime, focused almost exclusively on the specialisation of production and increasing economies of scale, have been of little interest to farmers wishing to develop their farms along other pathways.⁵

At the same time, transaction costs are generally very high due to the biological nature of the production process and its dependence on environmentally specific and variable factors (such as climate). Agriculture is also characterised by conditions of uncertainty connected with the institutional context (market and technologies of social preferences).

There are a number of strategies open to farmers seeking to minimise transaction costs. They can:

- internalise research and development activities within the farm itself, leading to a particular and individualistic pattern of resource use and to a particular farm development trajectory
- collectively internalise these activities through membership of formal organisations (co-operatives, etc.) which assume the role of the firm in pursuing innovation. In this case the organisations take on the role of the firm in the production of innovations. This is clearly illustrated by Benvenuti (1982a) who describes the processes of incorporation and institutionalisation⁶ generated by the *Technological – Administrative Task Environment (TATE)*.⁷
- internalise innovation within a local production system. In this case the circulation of information and the existence of reciprocal relationships (or, at least, relationships that are not based exclusively on financial considerations), allow for the transfer of, even strongly contextualised, knowledge from one farm to another without incurring excessive transaction costs (Dei Ottati 1995).

These different mechanisms for innovation (which may be adopted in combination as well as individually) partly explain the origins and development of different farming styles⁸ (van der Ploeg 1990a; 1990b; 1994). The concept of farming styles has been used to describe the rich heterogeneity of approaches to farming that can be found to exist within any given region, operating within an apparently uniform and inflexible techno-institutional regime. Such descriptions show how farmers are able to carve out 'protected spaces' and make technological and organisational choices within such a regime. Today the relevance of some of these choices is becoming of more general interest as the resultant agricultural production processes appear more in harmony with criteria for environmental and social sustainability.

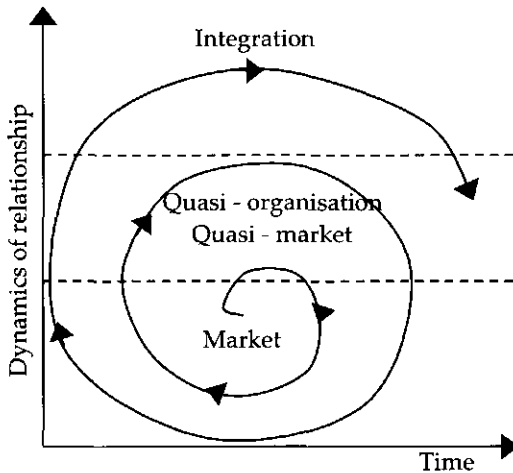
Innovation in agriculture as an endogenous process

Innovation may be described as the process that makes it possible to realise new competitive advantages through new forms of production, new products, or new methods of organisation. It is not simply a choice about what to produce or what technique to employ, but rather a 'process' that has a temporal dimension and takes place within a specific environment in which there are pre-existing constraints and opportunities.

A distinction needs to be made between the *continual* nature of innovation processes within a firm and the *discontinuous* nature of the diffusion of (successful) innovations. Firms innovate continuously; they experiment or imitate what other firms (even in very distant places and times) have

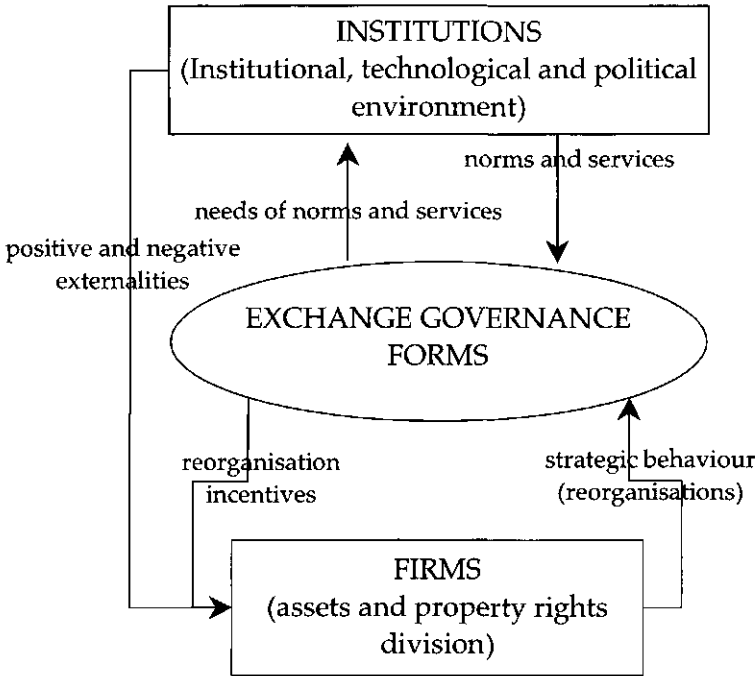
done. Not all these innovations prove to be 'efficient' or successful. Sometimes they fail for reasons internal to the firm. At other times they fail because of external reasons. Some innovations simply do not meet the objectives that underlay their adaptation, which may often include making better use of redundant or under-utilised resources in a new technological set-up. In such cases the entrepreneur is likely to abandon the innovation before restructuring his or her organisational set-up. Innovations always lead to a change in the organisation of the firm. This translates into continuous changes in resource use, in the exercise of property rights over such resources and in the relations between the firm and its institutional context. The firm is continuously repositioning itself, a process that Saccomandi (1998) defines as the organisational innovation cycle (see Figure 2).

Figure 2 Organisational innovation cycle



The methods through which such adaptations come about, and the speed with which they occur differ from one firm to another. They can be immediate, with the adaptation leading to the creation of new (or abandonment of old) organisational forms, which lead to changes in the entire structure of the firm. Equally they may be gradual adaptations that do not immediately lead to organisational changes in the firm. In either case, the patterns and methods of resource use (the production functions) are modified. New resources may need to be introduced, others augmented and others may become redundant. This process of adaptation illustrates a more fundamental characteristic of the firm being rooted in a dynamic organisational context, in which it is constantly redefining its boundaries and its relations.

Figure 3 Redefinition of the exchange governance forms



The representation made by neo-classical theory of the market as the most efficient method of exchange is thrown into doubt by empirical evidence of the existence of alternative forms of exchange that, in specific institutional contexts, prove to be more efficient than the market. Neo-institutional theory explains the existence and success of these forms of exchange through the concept of the cost of using markets. As discussed in the previous section, these costs are related to a number of factors: the impossibility of achieving conditions of perfect information; the behaviour of economic agents with limited rationality, and the specificity of the object(s) of trade.

The choice between recourse to the market or the internalisation of the exchange within an organisation (i.e. Williamson's 'make or buy' choice), depends on the resources (assets) available to the organisation and the distribution of the property rights over those resources. Institutional, technological and political factors all influence the very definition of a resource, its specificity, and the distribution of the property rights over it. In other words, the cost of using a market and the costs involved in reorganising a firm vary according to these exogenous factors. As a result firms are involved in a continual reassessment of the most efficient form

of governance (see Figure 3). This is not solely limited to a choice between the market and the organisation, but can encompass a range of hybrid forms of quasi-organisation and quasi-market options (Saccomandi 1998). In such options the exchange relations are not only regulated by the price but also by other variables that include the characteristics of the products and the existence of social rules of behaviour that reduce the costs of market use.

The dynamics of these changes vary, because of differences in the speed with which the external institutional contexts change and the speed with which the preferences of individuals seeking to safeguard the assets over which they have property rights evolve. The modernisation of agriculture has diminished the importance of the assets over which individual farmers exercise property rights (i.e. land, local knowledge and labour). At the same time it has increased the importance of those assets, both tangible and intangible, over which other parties control the property rights (i.e. seeds, machines, chemical products and administrative and market services). This has led to the organisational dominance of the institutional and technological environment over the farm. Choice of the forms of governance of exchange to be employed has passed from the farm to those industries that produce technological inputs and process agricultural outputs. This has imposed a reorganisation upon farms that has aligned them more closely to development models that give primacy to specialisation and achieving economies of scale. For individual farms the costs of conforming to these rigid organisational structures has often been very high. Equally these development models have failed to meet broader social objectives, such as protecting family farms, rural employment or maintaining a diverse and attractive countryside.

We can consider the farm as an organisational unit, whose initial status with regard to the governance of exchanges and control over assets is related to the functional space of the farm (that is its unique agro-ecological and socio-economic characteristics). When the innovative process leads to a repositioning of the farm *vis-à-vis* its Technological Administrative Task Environment (TATE) we can speak of a 'break innovation': a radical repositioning of the framework in which a farm operates. This might create a completely new governance structure and therefore represents a fundamental change in the relational pattern between the farm and its TATE. This might be exemplified by a change from a simple sales contract to a fuller integration with a processor or distributor. Such a systematic organisational innovation can often lead to the emergence of new power relations between the actors concerned.

On the other hand, when the innovative process leads to a co-operative form of adaptation between the farm and its TATE, this is more of an incremental innovation. This process may also lead to a change in the power relations⁹ within the TATE.

When a farm abandons the TATE constructed by the dominant technological regime, it enters the field of novelty production. Many of these novelties closely correspond to the new and emerging forms of agriculture. While the farmers themselves may feel that they are moving into uncharted territory and lacking adequate support, they are in fact part of a much broader movement. It is therefore extremely useful and important to create a protected space around them that makes it possible to move beyond the niche dimension in which such novelties are usually confined.

The process of exclusion of farms from incremental innovative processes within the dominant technological regime has led to the creation of micro-TATES that provide a protected space for novelties. These micro-TATES create an environment in which the chance of survival of these farms (previously considered to be marginal) is enhanced. Thus, some novelties have emerged, in response to earlier failure of the dominant technological regime to engage with and enlist rural areas or farming styles that were considered marginal and which never shared the regulatory ethos of the dominant regime. For this reason, these novelties have their own history and development course, which has entailed both 'break' and 'incremental' innovations. The innovation process therefore can lead either to the construction of a new relational network or to the strengthening of the existing one.

The neo-Austrian school (Amendola 1972; Amendola and Gaffard 1988) considers the innovative process as an interactive one between the farm and its environment, which provides opportunities for the creation or development of new resources. Seen this way, the innovation process consists of a period of learning and a period of structuring new processes, which together lead to new production options. The process of innovation therefore depends on the existence of systematic relationships between the farm and the market (its reference environment).

The mechanisms through which information, formal and contextualised knowledge are generated are decisive factors in this innovation process. They offset the constraints posed by the limited rationality of the economic agents and reduce the insecurity associated with the innovative process. The capacity of the farmer to involve other economic actors in the process of elaborating innovative solutions is a key factor in this process of combining formal (exogenous) knowledge with contextual (endogenous) knowledge. These other economic actors may include firms within the same sector, firms in other stages of the product chain or consumers. Such alliances serve to reduce uncertainty (as they bring in actors with other areas of expertise). Through working with other actors the firm (farm) is no longer acting in isolation and its innovations are informed by the requirements and expectations of others (and vice versa). Therefore, the creativity of the firm is developed by factors that extend

beyond the economic logic of reducing production and transaction costs and come to include the strategic dimension of entrepreneurial activity, personal inclinations, and socio-institutional context. This gives firms a different perspective when making choices between innovating or adopting an innovation developed by others. If we consider the firm in terms of a system, we can interpret innovation as an event that alters the balance of the system, which later returns to a new state of equilibrium. This new equilibrium may be reached through changing the structural elements of the system and their inter-relations or it can involve maintaining the boundary of the system itself or changing it.

Innovative processes take place in a situation of uncertainty, caused by the limited rationality of economic agents, who operate within a given procedural logic of choice and on the basis of those opportunities that they know about. Recognition of this aspect of the innovation processes raises several issues of both a theoretical and practical nature. Technical progress cannot be considered as a factor that is totally exogenous to the production process (i.e. generated in institutions such as universities). Rather it is the result of an interactive process between the firm, already operating according to a certain production technique, and the scientific and technological regime(s) with which it relates.

The diversity in the processes of innovation, and routes towards it, depends on three aspects:

- In the first place, economic agents do not start from a common footing with regard to the choices and evaluation of opportunities that they are able to make. These choices depend on their expertise, which in turn is derived from their history and learning experiences, from the other agents with whom they interact, and the context in which they operate. This means that at any given time the potential (or 'virtual') opportunities are much broader than their degree of economic exploitation (Dosi *et al.* 1988a).
- A second aspect is connected with differences in 'expected utility' that the economic agents have of a specific production process or function. This will be closely connected to the different strategies they employ. A specific process or function may have a different role or potential within different firms (farms). This expected utility is likely to be determined by observations of what is happening in the surrounding environment; for example (in the case of imitative behaviour) the results obtained by other firms.
- A final aspect is connected with information. Here it is important to distinguish between the availability of information and the capacity to elaborate and use this information.

Firms innovate and experiment continuously, guided by the idea that it is possible to create or discover opportunities to improve their performance.

Their understanding of an improvement is in turn guided by their own (self) regulatory structure and guiding principles.

The 'virtual' type of opportunity stems from two observations: Asymmetries in information do not allow agents to know, or experiment with, all the possible alternatives provided by technology. From an economic standpoint this translates into the assumption of limited rationality of the economic agent, which does not allow him to evaluate the possibilities of economic exploitation of all the various opportunities. Even where there is perfect information, this is not sufficient to trigger an innovative process. The capacity to elaborate an innovation is also a constraining factor in this process. In addition to this, actors also have very different levels of expertise. This may be due to their history, their relationships with other actors, the context in which they operate, and many other factors (Dosi 1990).

These elements can explain the existence of different performances, even amongst firms within the same sector and in the same territory. The possibility of exploiting virtual opportunities thus depends mostly on the capacity of the agents themselves, and is connected with their learning routes. These, in turn, depend on their experiences, in the various functional contexts of the firm, on extra-economic relations, and on the mechanisms for regulating them¹⁰. This refers to the cumulative and specific nature of the innovative process and to the specificity of technological knowledge within any given firm (Pavitt 1987).

Real opportunities are defined by the ease with which economic agents can innovate. Initially this involves identifying and selecting new or existing technologies (often from a large pool of potential ones) that are most appropriate to their technological and organisational structure. Later it involves incorporating them within the firm, in a manner that will guarantee the continued success of the companies' activity. The realisation of such opportunities depends, in large part, on the firm's capacity. It is also strongly influenced by the institutional context, in which the firm exists and its capacity to determine the development routes of an adopted technology and to create a protected space around it that will facilitate its adoption and diffusion¹¹ (Malerba 1988; Malerba and Orsenigo 1990; Rip 1995; Rip *et al.* 1998).

In the case of a farm, it is unlikely that the innovation process will remain confined to a single process, phase or entrepreneurial function. Rather we are more likely to be faced with complex innovative processes that may ultimately lead to a redefinition of the very boundaries of the firm/farm. This will occur through a succession of continuous adjustments that are driven by the need to find solutions to the constraints that emerge once the initial project has been embarked upon. This is related to the systemic nature of agricultural activity, in which the modification of an input often

leads to different product characteristics or, *vice versa*, the introduction of a new product leads to a reorganisation of the use of the production factors.

The innovative process in agriculture may thus be viewed as a continuous interaction between the internal context of the farm and its Technical - Administrative Task Environment (TATE). However, this external environment is not as rigid or monolithic as earlier descriptions imply. The possibility of access to information, now vastly expanded through modern communication technologies, the increase in the number of farm entrepreneurs with roots outside of farming and the growing importance of consumers in the construction of quality definitions of products have all contributed to a proliferation of micro-TATEs, within which farmers can develop their project ideas, always taking into account the endogenous resources they have available.

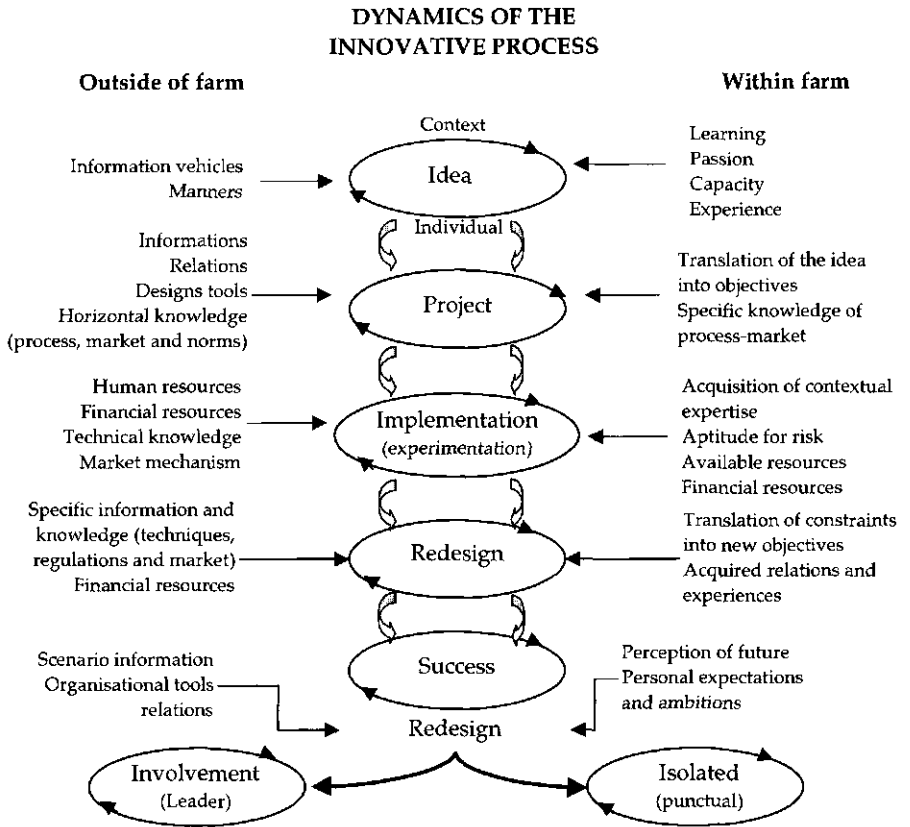
These interactions between the farm's internal and external contexts are illustrated in Figure 4. These shows how these interactions help shape the innovative process, its potential for success and the time that this is likely to require.

The interaction between the farmer and the socio-economic and institutional environment also plays a decisive role in the adoption of innovations throughout an area or region. Even when other actors recognise the value of an innovation, it is not always adopted. Thus the role of the institutions, that provide services and incentives (and sometimes disincentives), is very important in determining the uptake of a 'successful' innovation and developing its potential as a possible tool for triggering broader development processes in the area.

Paradoxically, innovations are often only acknowledged as such when the actual innovative process has ended: at the moment when the farm, that has generated new tangible and intangible resources, and created a new relational structure based on these resources, implements strategies for defending the investments made during the innovative process. These investments may be 'intangible', taking the form of specific and contextualised knowledge about production processes and markets, a re-organisation of labour, or new inter- and intra-company relationships whose purpose is to develop a form of governance that minimises the transaction costs associated with the farms' market exchanges.

This stage of defending an innovation does not represent the end of the innovative process, but continues as an ongoing, gradual redesign, now mainly aimed at safeguarding the investments that have been made (which now form part of the farm's specific resources). At this point farmers may also seek to create organisational arrangements with other farmers (or other actors in the supply chain) to safeguard their innovation.

Figure 4 Interaction between environment and farm in the innovation process



The redefinition of the firm’s boundaries: the success of the novelty

Innovations within farms always occur within the context of the farms’ short and long-term management strategies. Even when the innovation is limited to the introduction of a single machine or a new technology in one single process stage, this will, in the short or long term, lead to a reorganisation of the farm’s resources and, therefore, of its organisational structure.

Earlier, we defined ‘break innovations’ as those that bring about an organisational change. These occur when a farm internalises or externalises several phases of the production process or several production functions and they are accompanied by changes in farm transaction and governance costs. Sometimes these changes are immediate and lead to changes in the reference context of the farm, i.e. they lead to a new position within the innovation cycle.

One key effect of the dominant technological regime has been to progressively incorporate farms within the market. Thus, the re-introduction of production processes and firm functions, back into the farm, may therefore be considered a novelty, since it runs against the current of the dominant technological regime. The reintroduction into the farm of processing and marketing activities is a form of vertical integration, which is becoming more frequently adopted as a response to increases in market uncertainties and diminishing returns from commodity markets.

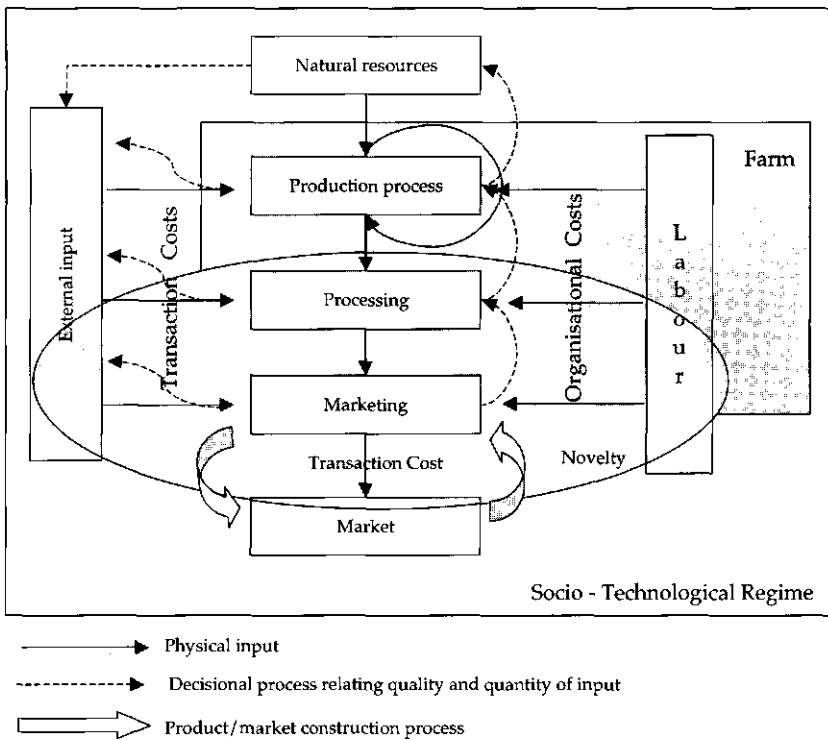
One interesting aspect of this process is that the internalisation of these functions is connected to a modification of production techniques, which must be adapted to the (more) artisanal nature of production. This can often lead the farmer to re-acquire an interest in, and knowledge of, the relationships between cultivation techniques and the qualitative characteristics of his products. Examples of this can be found from studies of animal husbandry and organic agriculture. Thus, for example, the opening of a local or on-farm butchery may entail the reintroduction of fresh forage into the feed of the livestock (displacing ensiled fodder) in order to improve the organoleptic characteristics and preservability of the meat. Or, on-farm processing of pecorino cheese will require paying attention to, and gaining knowledge of, the types of grazing areas that give this particular cheese its unique characteristics. Such changes often result in environmental benefits as well. In the first case, the abandonment of practices entailed in producing ensiled fodder (particularly maize) can lead to a reduction in soil erosion and pollution of groundwater. In the second case traditional types of grazing areas that were progressively being abandoned are reinstated and safeguarded (Biondi 1999; Biondi and Taffetani 1989).

From an economic standpoint, such vertical integration implies a decrease in the market transaction costs for inputs, which is accompanied by an increase in the farm's governance costs. These costs can be minimised through the creation of economies of scope in the joint use of farm labour and other resources. The existence, within the family or the local system, of specific knowledge, required for the (re)-introduction of the new production processes, thus becomes a decisive factor in the process of organisational innovation, since it considerably reduces the transaction costs connected with developing this resource. Because of the specificity of this knowledge the costs of acquiring it through other means would be extremely high.

All the activities connected with the reorganisation of a farm involve transaction costs, which are sometimes referred to as 'transition costs' (Pagano 1993). Such an organisational change leads to a change of the reference markets for both inputs and the sale of products (see Figure 5). The magnitude of these transition costs therefore depends on the

existence and structure of markets that differ from those in which the farm previously operated, and which had determined its organisational structure (the choice between 'make or buy'). The transition costs also depend on the history of the firm itself and its development pathway. The time required for such a transition from one organisational form to another depends on a number of factors. These include: the type of innovation, the flexibility of the farm in the use of the resources that will be made redundant, and the inertia imposed by investments¹² associated with a firm's modus operandi. For example the presence of a strong local co-operative organisation would represent an element of inertia to the vertical integration of a family farm.

Figure 5 Organisational innovation



Within the dominant regime in agriculture, technological innovations that aim to increase resource-productivity often seek to replace the 'limiting resource'¹³ by artefacts manufactured in the agro-industrial sector¹⁴. By contrast, novelties often represent a way of organising endogenous resources so as to circumvent the constraints implied by the limiting resource, using strategies for diversification and/or the generation of - internal and external - synergies. These strategies emphasise the

economies of scope which, as we have seen, can facilitate a reduction in production costs and an increase in output value.

The very definition of marginality derives from the inability of the farms to respond to technological innovations with increases in productivity comparable to the top areas/farms. The limited effectiveness of these technological innovations, however, was often disguised through raising the level of opportunity – that is, by creating easy access to these innovations through a system of public support (contributions to investments) and technical assistance.

In all rural areas the development trajectories of agricultural activity are embedded in and, hence, dependent upon specific socio-economic and environmental contexts. Currently, many farmers, especially those in ‘marginal areas’, are structuring their development trajectory as an ongoing process of downgrading. From an economic standpoint downgrading can be seen as way of replacing resources brought in from outside of the farm, by those resources generated within the farm through the production process itself or additional processes.

Endogenous and exogenous resources¹⁵ in agriculture are not perfectly substitutable and it is not always possible to replace one with the other. Often the replacement of endogenous resources by exogenous ones leads to the complete disappearance of the use of one or more of these resources in the production process. The specificity of soils and the pedo-climatic conditions in which the farmer operates as well as the influence of history on natural and human resources and capital, means that this process of substitution is not neutral. This is particularly true in regard to two important variables: environmental sustainability and the economic returns of the farm.

The search for economic efficiency, viewed as the maximisation of profit has historically been a key objective of agricultural modernisation. This process has led to agricultural activity becoming progressively disconnected from the endogenous resources on which it was once based (van der Ploeg 1994).

Within the modernisation framework innovation processes are inspired by the Fordist model of industrialised mass production within which intensification and standardisation are central. The pursuit of technological progress capable of increasing factor productivity, provided farmers with technologies created outside of the farm. The adoption of these innovations has been facilitated by the emergence of TATE as the techno-institutional environment within which farmers have to order their business relations and practices. This environment has played an important role at several different levels: the development of technology in research centres; the adoption of technologies by farms, through a system of incentives and services; and, more generally, the creation of an

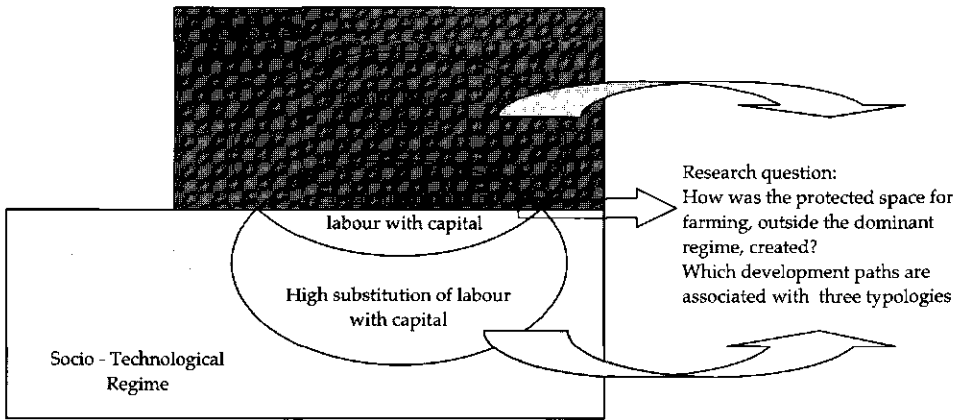
abstract stereotype of a modern and successful farmer (van der Ploeg 1999).

Farms have adopted different positions in respect to the dominant technological regime. In marginal areas three main positions can be identified (see also Figure 6).

- 1 Farms that have wholeheartedly followed the technological regime, trying to imitate the performance of the farms for which the technological regime was constructed (even though they are located in different contexts/areas). These farms have invested heavily in automation and in structures that aim to overcome the limits imposed by natural conditions (infrastructure, climatic conditions) and in increasing the productivity of natural and other farming resources (e.g. fodder, fertilisers, seeds, the introduction of improved breeds, artificial insemination, etc.). The high production costs associated with the difficulties of absorbing (unsuitable) investments into marginal farming areas and the low profitability of the investments themselves have both contributed to widespread failures of this approach. Signs of this failure are often evident in the most marginal areas, such as mountainous regions. The presence of abandoned barns, often never used, and machines and equipment that are either oversized or unsuitable for the soil or local relief sometimes provide tangible evidence of this failure. Such innovations are often introduced because of the farmer's belief in the modern agricultural model and have been strengthened by patterns of imitation among farmers who do not want to feel left out. Such farmers have often made investments that are not suitable, or at least not necessary, for their farms. The result is that these investments have been under-utilised (or sometimes not used at all) and have often not proved profitable.
- 2 Farms that have only partly adhered to the dominant technological regime, carefully selecting the technologies and adapting them to their own organisation of the production process and the functions of the farm. An important element of this strategy is often the family base of the farm. Decisions regarding investments and the introduction of innovations are made within the family, which evaluates not only the economic profitability but also the new work division that these changes will bring about and the extra-farm requirements of the family itself (e.g. children's education). Furthermore, regional extension services have, in some cases, mediated the introduction of innovations, trying to steer the farmer's choices towards those technologies that are most appropriate to farm household aspirations, which are also often the technologies that are most compatible with local environmental conditions.
- 3 Farms that have resisted the modernisation process. These farms are considered to be marginal by the dominant technological regime. They

have continued to use family labour as their main resource. They may have made few investments in structures and automation and may also have implemented strategies designed to enhance the artisanal characteristics of their own farms. These farms have a strong family character, and often implement forms of diversification which include activities outside of agriculture, often integrating these activities with those of the farm. Because they are considered marginal, the strategies of such farms have often remained hidden, whilst the farms themselves have survived within a protected niche, outside of (and ignored by) the dominant technological regime. Their continued success and/or survival derive from their capacity to build themselves a market capable of increasing the value of their production.

Figure 6 Farm strategies in response to institutional changes in Abruzzo mountain areas

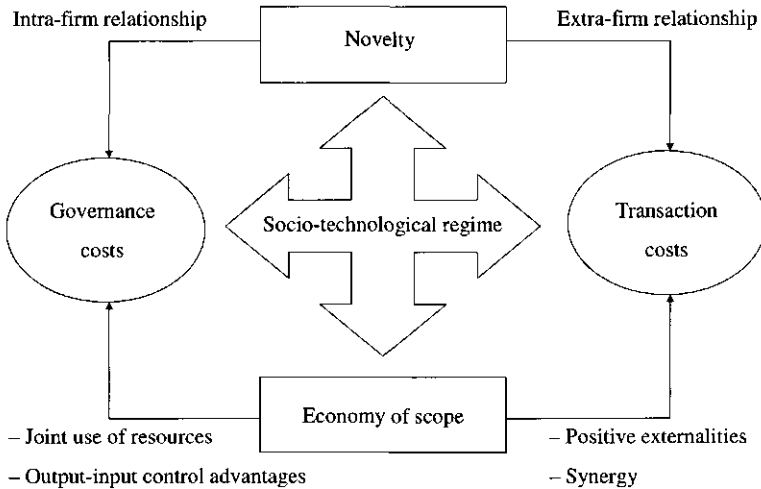


In marginal areas the model of mass production has often failed due to the inappropriate nature of cost-saving or production enhancing technologies in these areas. Often the lack of resources and their specificity have made it even more difficult to successfully adapt such innovations to local conditions. Such failures have brought about survival strategies that no longer aim to maximise output (competition strategies related to cost) but which seek to integrate activities downstream of the agricultural production process. Such activities may fall outside of classic definitions of agriculture, but are capable of creating economies of scope through the use of farm resources, (e.g. holiday accommodation environmental services, etc.). Such an organisation of the innovation process has led to the reintroduction of technological innovations in both agricultural production processes as well as at other stages, such as in on-

farm processing. As such this has also led to newly emergent uses for natural resources within the farm.

The failure of the technological regime in meeting criteria relevant to internal farm management has been paralleled by a general inability of the dominant technological regime to guarantee consumer safety or maintain environmental standards and quality. Recent trends in the development of technologies have started to accept this and focus upon production factors and methods that are more compatible with the ecosystem. However, the construction and adoption of these technologies does not significantly differ from those they are replacing. Finally, there are alternative patterns of innovativeness (of novelty production) that coexist with, and start from, the existing technological regime. These patterns will always lead to a change in the organisation of the firm resulting in changes in farm governance costs¹⁶ and the cost of using the market (see Figure 7).

Figure 7 Novelty impact on firm relationship and economy of scope response



In many contexts such costs also depend on the institutional framework within which the farm operates. In many cases the institutions internalise a considerable portion of these costs. Agricultural policies can change the distribution of transaction costs between the various economic and institutional operators. According to neo-institutional theory, there are different forms to govern transaction costs. These different forms of governance are the result of the firms' position within and interaction

with the institutional context. The role of institutions thus becomes important in creating the conditions for the innovation.

The organisation of the innovative process and the institutional context

The learning process that generates innovations may be situated either within or outside the firm. According to Teece (1982; 1986; 1988) decisions concerning the organisation of this process depend on the transaction costs associated with specific and tacit forms of knowledge as well as on the possibility of the innovation itself being appropriated by others. Keeping innovations within the organisation provides an alternative to the market: one that can potentially reduce transaction costs. In agriculture innovative processes are characterised by a strong division between formal and informal organisational forms. The contextualisation of knowledge in agriculture is often learned collectively, which can be explained by two main reasons:

- the homogeneity of agro-pedo-climatic conditions within a specific territory, increases the possibility of a rapid transfer of successful innovations made by individuals through imitation;
- the positive externalities deriving from such rapid adaptation. When co-ordinated such changes can generate the critical mass necessary to achieve the economies of scale required to satisfy market demand, even if that demand is framed within the context of mass production.

These characteristics become transferred to all the learning phases, even those concerning the generation of formal knowledge, the establishment of public research centres and the support services capable of successfully engaging with farmers. The progressive modernisation of the agricultural sector has acted as a filter selecting those farms that find it worthwhile to remain within this organisational structure. This process was preceded by the pre-eminence given to formal scientific knowledge over contextualised knowledge, not only within the farm, but also within the socio – technological and institutional context (TATE) constructed around the farm (with public research and service centres being integral parts of it). At the same time, this formal knowledge strongly intertwined with the logic of economies of scale and the advantages deriving from network economies, in which innovations are adopted by a very large number of parties. The ‘scientification of farming’ implied an increasingly limited space for manoeuvre for those learning phases whose focus was upon contextualising technologies. For example, today’s agricultural machines are a combination of technologies that come from very diverse scientific fields (electronics, mechanics, hydraulics, material engineering) and are produced in very specialised contexts. The combination of these various kinds of knowledge is now not only external to the farm, but also external to TATE itself. It is no longer only the farmers who lack the expertise to

repair and maintain agricultural machinery. Because of their technological complexity, even the suppliers themselves often need to resort to specialised personnel from the firms that manufactured individual components. As the resulting technologies and techniques are socially constructed through connections and relations of a social-technical nature (Benvenuti 1994), this process means that these social constructions take place in environments that are increasingly distant from the farm and its organisational context of reference. Thus farmers are less able to play an interactive role with the actors devising these new technological solutions.

We thus move from a 'weak' or inter-institutional organisational dominance exercised by the TATE to a 'strong' dominance by economic actors who control the production of knowledge, artefacts and the division of learning processes. The effects of this dominance have been described by a number of authors (see Nelson and Winter's *Technological Regime* (1982) van der Belt and Rip (1987), Dosi's *Technological Paradigm* (1982; 1984) and Freeman and Perez's *Techno-Economic Paradigm* (1986)¹⁷). The cumulative nature of the learning process allows a progressive internalisation of knowledge within organisational structures that are reinforced by socially and technologically constructed ties¹⁸. These organisations, which may be traced to the TATE and to the public Scientific and Technological System, have become increasingly self-referential. As a result they are less able to respond the needs of farms or to those of civil society. In consequence many forms of innovation devised by formalised technological knowledge are redundant, as there are limited possibilities for combining and internalising these innovations on real farms. The technologies are produced on the basis of a virtual representation of the 'farm of the future' rather than in the context of actually existing farms (van der Ploeg 1999).

As a result of this we can conceptualise the innovation processes as following two distinct paths. The first involves the internalisation of innovative process within the farm itself, mainly through new territorially localised organisational forms, which are sometimes even inter-sectoral (as is the case with the Tuscany wine routes; see Brunori *et al.* in this book). The other involves the complete externalisation of the learning process to external agencies, which means that these agencies expropriate the cognitive element of innovation, leaving the farm only the work of implementation.

The first path is characterised by farms that reorganise their entrepreneurial activity towards multifunctionality, where complex innovations – of product, process, and organisation – predominate. These farms operate in market niches where the competitive advantages are connected with the inter-sectoral relations and the synergies with other activities of the territory, and with the farm's capacity to continuously

readapt its commercial strategies towards new markets. These niches are characterised by 'alternative' micro-TATEs, whose expansion is often hindered by the dominant regime and the norms that it imposes. In other words, the innovations that characterise these niches often do not succeed in becoming technological trajectories because of inadequate organisational and institutional support.

The second path is characterised by the acquisition of innovations directly from the global market, where the mechanisms of dominance are constructed by single actors through the almost monopolistic control of research and development functions, driven by productive and commercial logic. In fact, these firms, in addition to selling the artefacts coming from highly specific scientific and technological knowledge, often impose contracts for the supply of the technical and logistic assistance necessary for the production and marketing phases, and control the latter through forms of royalties.

Paradoxically this leads to the institutions that have traditionally formed the core of the TATE becoming the weakest link in the organisation of the innovation process as they are progressively excluded from the innovation process. The weakness of this link reinforces this process (and the process of organisational dominance within the sector), as the actors responsible for negotiating the trade offs between the private interest of agricultural entrepreneurs and society at large have a greatly diminished role.

The creation of protected spaces

Institutions have the capacity to intervene in three spheres that, according to Nelson and Winter (1982), provide the characteristics of a technological regime: opportunity, appropriateness, and accumulation of knowledge.

Opportunity refers to the ease with which economic agents can innovate and identify the pool of untapped potential within each technology. Appropriateness refers to the capacity of innovators to make personal use of the results and derive profit from an innovation – in other words, the possibility of using an innovation as a factor of differentiation and competitiveness (Malerba and Orsenigo 1990). The accumulation of knowledge can occur at two levels: at the farm level and at the sectoral level. In the first case it is led by the owner's capacity to learn, which is closely linked to his willingness to innovate. In the second case new innovations depend strictly on previous ones and therefore the technological process proceeds in an incremental fashion on the basis of the available knowledge. Hence, path-dependency becomes a built-in feature.

In agriculture, opportunities are politically structured by a system of financial incentives and by public and private extension services. The political preference for the modernisation paradigm has led technology in

the direction of constantly increasing economic efficiency, in narrowly defined terms. The appropriateness of the technological regime has often been limited by the standardising effect of the modernisation trajectory, which aims to produce uniform inputs for the agro-food industry. Thus the appropriateness of innovations has been constrained by the requirements of the food processing industry (at one end of the chain) and the development of agricultural technologies designed to meet these requirements at the other. Finally, accumulation of knowledge at the farm level has been progressively reduced, while at the institutional level it has grown considerably, especially within the biochemical field. At the farm level, the pace of technological change rarely leaves enough time for the farmer to learn the processes involved, creating an ever increasing dependence on technical experts. These experts have become increasingly integrated with industry, partly as a result of the processes discussed above, but also partly because of the general privatisation of extension and support services, which has occurred because of political aims of reducing public expenditure.

Farms' relationships with these three different spheres vary widely as farms have different assets and different organisational forms. Such differences can be found even within a single territorial area, where very heterogeneous styles co-exist. Furthermore, the presence, even within the dominant technological regime and/or single territory, of a great variety of innovative behaviours and different manners of organising the innovative process (Malerba and Torrisi 1990) can also be explained by the existence of different external contexts and the varying backgrounds and attitudes of individual entrepreneurs. It is possible to recognise different entrepreneurial approaches that aim at reducing uncertainty, and different learning processes which, since they are cumulative by nature, come to depend on the very history of the farm. In addition different mechanisms (including authority, loyalty, etc. depending on the social and political context) influence the degree of organisational inertia.

Heterogeneity may be found within a single technological regime or in the simultaneous existence of several technological regimes. In the case of a single regime this may be explained as a result of farms with different patterns of incorporation and institutionalisation (van der Ploeg 1990a). A greater emphasis on the economic aspects of farming may lead a farm to delegate more activities to third parties. In fact, institutionalisation often obliges farms to accept instructions as to what to do (power of allocation) and how to do it (power of authorisation), placing them in what we have called a technological trajectory (Benvenuti 1982a).

From the economic standpoint, innovation can lead to a competitive repositioning of the firm/farm. However, technological innovations in the agricultural sector are increasingly characterised by their low level of appropriateness to farms. This is because of strong private sector

involvement in the organisation of innovation, which has led to an overwhelming priority being given to standardisation and the pursuit of economies of scale. This has configured the market of agricultural commodities to a competitive market (Baumol *et al.* 1982). Agricultural markets are currently characterised by a nearly complete lack of technological entry barriers, where the economic agents behave like price takers and the only possible strategy is that of cost reduction. Such reductions are pursued through economies of scale and the introduction of associated process innovations. Under such circumstances it becomes almost obligatory, for farms, to adopt such innovations, to the point where their adoption becomes incompatible with the continued existence of the farm itself.

When several technological regimes exist simultaneously, heterogeneity is guaranteed by the social construction of protected spaces, market niches, local systems, districts (Iacoponi 1999), etc. In these protected spaces, the organisation of the productive process and the farm's relations with its own institutional environment are consistent and support self-referential forms of 'efficiency'.¹⁹ Therefore it makes little sense to speak of economic efficiency of individual farms. The key issue that emerges is the efficiency of the institutional system (farms included) as a whole. Both the institutional environment and the farm innovate continuously; however, these mutual processes of farm – environment adaptation do not take place in the same way for all farms. Inertia and resistance to innovation, which is generated both by the farms and the institutions themselves, hold partly back such processes.

The strategies of firms tend to place a high priority on defending assets (in order to maintain their future use) and maintaining the relationships (organisational form) that they have constructed. The organisation of the firm is, in itself, an investment: one that will reflect the firm's strategy for managing transaction costs in the past (*ex-ante* costs), present and future (*ex-post* costs). Membership of an organisation (such as an agricultural co-operative), gives rise to forms of loyalty, that might exclude new solutions and ways forward. Similar inertia may also be caused by mechanisms such as reputation and authority that have evolved as methods of regulating and minimising transaction costs.

There are often time lags in the innovation process and the institutional context and the firm do not respond to the changes simultaneously. This may generate forms of organisational inefficiency, which may imply costs that have to be shouldered either by the firm or the institutions. If this time lag lasts too long, the innovation may remain limited to one or a few firms who have created a protected space represented by a specific market segment, and the forms of governance of the transactions may not be reproducible on a broad scale. Many such innovations will have a short life, and even if they may represent a temporary success for the firm,

other firms will see them as representing an opportunity that is to be appropriated.

Opportunity and appropriateness are embedded not only within the technologies themselves, but also within the socio-institutional context. Incentives help define how opportunity and appropriateness are perceived. These incentives may be formal (as in the case of public policies supporting innovation, or informal, coming about through mechanisms of 'collective' diffusion). Such incentives may encourage different technological regimes to exist alongside the dominant one, even within a single territory. In time they may even evolve into a new regime that is capable of challenging or even supplanting the dominant one.

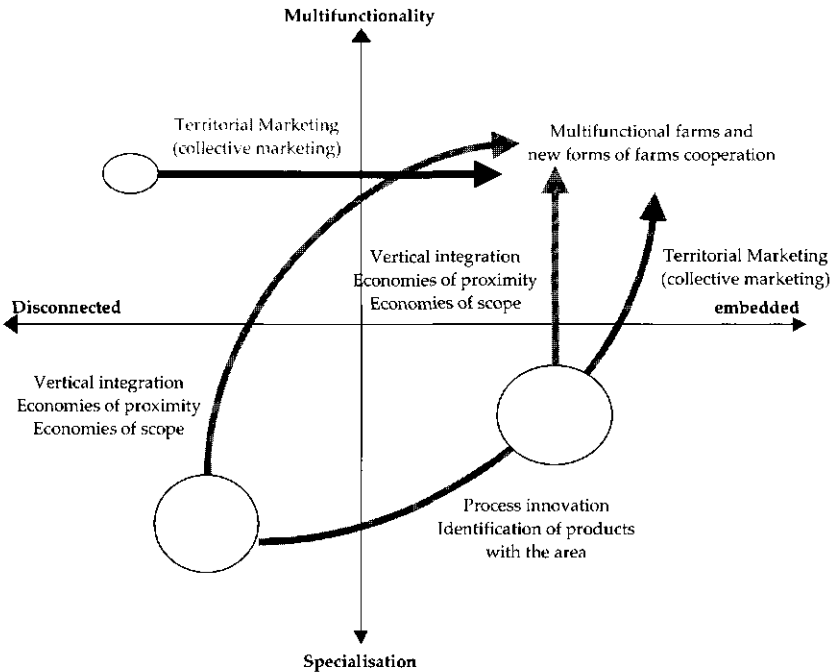
This innovative process will lead, in the end, to one of two extreme cases: the death of the firm or the adoption of radical innovations through which the firm changes its internal and external relationships. In agriculture such radical innovations often lead to a re-embedding of parts of the production process within the farm and a reacquisition of functions such as marketing that had become externalised.

A recent study carried out in three regions of southern Italy on the development paths of successful farms (Scettri 2001; Ventura and Milone 2004), showed how these paths, even though they start from different situations and contexts, tend to lead towards farm strategies in which multifunctionality and reconnection with the territory play a key role. This is achieved through the diversification of production (in the case of a multi-product farm) and/or an increase of the functional ties with the territory (services, intersectorial synergies).

The paths implemented, as shown in Figure 8, are varied: for example, the specialised farms have sometimes pursued strategies of differentiation of their products in the market which have, in turn, led to the rediscovery of the vocation²⁰ of the territory. This then comes to play a role in helping them maintain their competitiveness. Later they rediscovered synergies deriving from collaboration with other businesses, both in agriculture and other sectors (e.g. tourism, handicrafts, etc.) are discovered and explored. Equally, farmers pursue strategies of diversification, seeking economies of scope through the reintroduction of hybrid systems that result in a different use of the local resources in the pursuit of the 'vocalinities' specific to the area.

The crisis of the modernisation model in agriculture is encouraging these processes at a grassroots level. It is leading to a new regrounding (van der Ploeg *et al.* 2002), in which the functional connections of the farm to the territory in which it operates are strengthened. It is, however, a process which also requires institutional actors who can reclaim influential positions within the TATE, in order to stimulate entrepreneurial behaviour that is responsive to the emerging needs of the European society.

Figure 8 Different paths of innovative farms



Through these processes traditional agricultural systems are becoming increasingly differentiated not so much on the basis of specialisation, but more in terms of the specific relations that exist between farms and their economic structure of reference. Opportunities for extra-agricultural employment, connections with tourism and the environment and opportunities for transforming, marketing, and distributing produce all influence the direction that differentiation takes in different territories.

Novelties need a new political and normative scenario if they are to fully develop. In the absence of appropriate protection, many of the new agricultural activities will be stifled due to the presence of normative barriers associated with the dominant regime²¹. Furthermore, it is necessary that there is a series of conditions that consist of complementary assets, both tangible and intangible. In fact, the novelties consist of technical and organisational knowledge that make it possible to improve the production processes or the firm's functions, with respect to both the firm's competitiveness and, especially, to its compatibility with the collective prosperity. Especially when novel innovations are of the type that we called 'break', i.e. systemic, they need complementary investments²² (Teece 1986; 1992) that are part of the system itself, i.e. which concern the structure and organisation of the firm's new environment of reference. This is particularly evident with innovations that imply a multi-activity of the farm as, for example, in the case of agri-

tourism, where the presence of investments in sectors that are synergetic with them (infrastructure, public and private agencies) often determine the success and development of these innovations. Public intervention cannot, therefore, be limited to financing the specific investments that the entrepreneur makes in the innovation process, but must provide for measures that concern the complementary investments, both those made by the entrepreneur but more especially, when they are based on a functional type of territorial division among different sectors and/or firms.

The regrouping of agriculture (Iacoponi *et al.* 1995; Iacoponi 1999; van der Ploeg 2000) necessarily entails an enlargement of the institutional and economic framework within which the firm is operating. This creates new opportunities for the firm, but implies also an increase in the complexity of its informational and decision-making processes. Hence, the role of institutions in mediating the needs of the various actors, in the articulation and co-ordination of the different interests, and in supplying the firm with the instruments needed to govern such complexity, becomes strategic. From an institutional standpoint, this needs decentralisation of decision-making to regional territorial bodies and local organisations. However, this entails several risks connected with the territorial, socio-economic differences that characterise the European regions. Particularly the *shift from sectoral to integrated territorial approaches* might turn out to be difficult and risky – especially when the capabilities of regional administration and government are limited.

The territorial heterogeneity connected with the availability of natural resources, but also with the history of the territory and the heterogeneity of entrepreneurial styles, cannot be governed through common administrative rules, but requires common regulatory principles that must find, time and again, specific and variable forms of local application. This process of decentralisation has already started in Europe through sets of 'horizontal legislation' that must be applied by the single Member States.

Thus, the role of the State, regional and local Administrations, becomes itself a success factor for the firms, and therefore for the territory. This also holds true for the possibility of creating protected spaces for the development of novelties that meet the specific environmental conditions. In short, the decentralisation process needed to reorient agriculture towards a multifunctional role requires a reacquisition of the local administrative capacity to elaborate knowledge as well as the norms necessary for the construction of an adequate framework for bargaining. This must not lead to a confusion of roles: the political area remains responsible for the identification of the rules and the common priorities, whilst the administrations and firms are responsible for the processes of regulatory and operational construction of the local solutions. In this same

scenario, the roles of the research centres, universities, and technical assistance become important for the identification and validation of those novelties that may constitute a response to the failure of the dominant technological regime.

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Notes

1 Economies of scope exist when the cost of jointly producing outputs Y1 and Y2, is less than the cost of producing each output separately: $C(Y1; Y2) < C(Y1) + C(Y2)$

2 External economies are quite common; they derive from locational externalities and innovation in one industry that can lower costs in another (Teece, 1982).

3 In particular, the notion of support space is used to describe three kinds of 'non-market' relations:

- strategic relations of the firm that involve its partners, suppliers and customers (privileged exchanges of information, collaboration/partnerships/joint ventures);
- qualified or privileged relations at the level of organisation of the production factors (origin of capital, sources of information, technological know-how, participation in the formation of human capital and the processes of collective learning and formation of an innovative culture);
- strategic relations with the other collective actors of the territorial environment (public agencies, private or semi-public associations, trade unions, other groups).

4 These are linked to phenomena of opportunism and moral hazards deriving from information asymmetry and incomplete information.

5 This is not to say that innovation has not occurred in such areas – but rather that it has rarely been supported by the commercial or state organisations that drive 'mainstream' agricultural research.

6 'Incorporation' means the process of delegation outside, by a firm, of many of the production phases and functions; 'institutionalisation' refers to the effect of dominance, by outside agencies, that leads the firm to follow exogenous technical directives (Benvenuti, 1982b).

7 *Technological – Administrative Task Environment (TATE)* is the progressive interpenetration of the technological and the administrative dimensions (or variables) of the operating environment in which farms exist. Benvenuti identifies seven main elements in this environment.

- suppliers of labour input;
- customers of the farms products;
- suppliers of technical capacity and capital ;
- institutions or authorities with regulatory power over land and its use;
- competitors in the supply and final markets;
- other miscellaneous regulatory and advisory groups, including government bodies, local government units, trade unions and associations, and other territorial or sectoral associations;
- institutions and systems of information and scientific research.

The TATE provides an important element of the farmer's professional environment. It shapes the farmer's role by defining the behaviour or functions that are considered socially and technically appropriate (or inappropriate) for an individual operating within a given social and economic context (Benvenuti, 1975).

8 The heterogeneity of farming styles has been identified in empirical research carried out by Van der Ploeg (2000), Roep and de Bruin (1994), Wiskerke (1997) in Holland; by Ventura and Van der Meulen (1994, 1995a, 1995b), Ventura (1995, 2000), Ventura and Milone (2000) in Umbria; Ventura and Milone (2004) in three southern Italian regions (Sicilia, Calabria, Basilicata). These studies show how the organisational and technological set-up of the farm has a 'private' significance, i.e. it depends on individual choices made by the entrepreneur based not only on external pressures but also by the farmer's own strategic objectives made on the basis of the resources available to him and his interpretation of market behaviour and changes.

9 The strong influence of the TATE is due to its characteristic as a 'quasi-organisation.' This derives from the TATE being an accumulation of agencies and formal regulations that, even though it lacks a formal organisational structure, it nevertheless exhibits three fundamental dimensions typical of organisations. These include a) a (informal) structure, b) its own symbolic order, i.e. its own 'culture', and c) a function. The structure emerges 'automatically,' in the sense that once a certain degree of integration of the various parts of the grid exists, a web of limitations, opportunities and obligations emerges 'around' the firm. The symbolic order or 'culture' lies in the values and assumptions that are shared amongst the technical and organisational staff representing different agencies. Lastly, all agencies share a common objective of regulating the production process through the 'standardisation' of the productive behaviour of the actors in question. This in turn becomes the 'function' of the TATE (Benvenuti et al., 1988).

10 Recent research on the innovative dynamics in the agricultural sector carried out in three regions of the south of Italy revealed the diversity in innovative behaviour of the entrepreneurs in terms of their role in coordinating the production process and the entrepreneurial functions (inside and outside of the farm) according to their origin and previous experiences and relations (Scettri 2001; Ventura and Milone, 2004).

11 The role of the national research systems (the universities and public research centres) and of public policies and financial systems, in innovation processes has been the subject of numerous studies, including those by Orsenigo (1989) for the Biotechnology Industry and Iacoponi and Marotta (1995) for the agricultural sector.

12 These may include social, administrative and environmental ones.

13 See also Sonneveld *et al.* in this book.

14 Which in extremis can be taken as far as replacing the land itself with inert substrata

15 Endogenous resources are those whose utilisation and therefore reproducibility are mainly controlled by the farmer, who generally maintains property rights over them. Exogenous resources are those purchased by the farm, which have a limited lifespan, which cannot be reproduced within the farm and over which the farmer generally does not own the property rights.

16 Costs that are different from production costs although they are necessary for managing the firm

17 The Technological Regime and Technological Paradigm are characterised by their ability to define the important problems that must be tackled, the functions that must be satisfied, the technology to be used, and the resulting artefacts. The concept of Technical-Economic Paradigm also includes, in addition to the processes of engineering and production of new technologies, the changes to the cost structure, the conditions of production and distribution that result from the system moving from a micro-technological to a macro-technological concept. Dosi links this concept to that of *Technological Trajectory*, which is defined as the way in which technological progress contributes to shaping the development of the Technological Paradigm.

18 In this approach it is implicit that a technological trajectory is not an autonomous process, but is defined and structured through: the construction of a technical-scientific context that concerns both the importance of the problems, and how they are solved by the methods and techniques typical of the Technological Regime; an organisational and institutional context that defines procedures, technical standards, social norms and rules that concern manners of use of the resources and the division of the property rights over them; the development of infrastructure and demand (Rip et al., 1998).

19 The concept of efficiency is socially constructed as the optimisation of the functions of expected utility of actors characterised by limited rationality.

20 Vocationality describes the optimisation of agricultural practices in relation to the local conditions and natural resources used in the production process. The search for the

vocationality of a territory thus influences both the choice of systems and of the factors used in the production process (variety, breed, knowledge, etc.). Practices aiming to promote the vocationality of an area are inherently sustainable because they pay more attention to the reproduction of the natural resources used in the production process.

21 There are several emblematic examples in various European countries such as, for example, those of the environmental cooperatives in Holland or the services rendered by the farms that are poorly regulated in Italy (agritourism, environmental services, school-farms, etc.).

22 The complementary investments may be specialised, co-specialised, or generic. The specialised investments are those for which there is a unilateral dependence between the innovation and the investment. In the co-specialised ones the dependence is bilateral: one cannot exist without the other. The generic investments, on the other hand, are not dependent on the innovation.

4 The Power of Experience: Farmers' Knowledge and Sustainable Innovations in Agriculture

Marian Stuiver, Cees Leeuwis and Jan Douwe van der Ploeg

1 Introduction

It is starting to become widely recognised that farmers' knowledge has an important role to play in bringing about sustainable innovations in agriculture (Röling and Jiggins 1998; Chambers 1989; Hobart 1993). In this chapter, we first outline some of the backgrounds to this renewed interest in the potential of farmers' knowledge (Section 2). Following this, we discuss the characteristics of farmers' knowledge in more detail, and how it may differ from scientific (or scientists') knowledge (Section 3). This leads us into a discussion of practical ways in which farmers' knowledge may be drawn upon more effectively and the role that scientists may play in this respect (Section 4). In the concluding section we reflect briefly on the institutional changes that may be required in agricultural knowledge systems in order to stimulate scientists to take up this challenge (Section 5).

2 The agricultural knowledge system in transition

2.1 Introduction

In recent decades, great efforts have been made to modernise European agriculture towards high productivity and efficiency. This so-called modernisation process was assumed to be unilinear: the combination of scale enlargement and modern (science based) technologies was presented as the only route to success. Those who were able to make this combination were seen as 'vanguard' farmers and scientists (van der Ploeg 1999). This model encouraged, farmers to become more integrated in markets and dependent on the use of external inputs, technologies and capital (Toledo 1990; van der Ploeg and Frouws 1999). It encouraged a more uniform pattern of farming. As such it resulted in a weakening of linkages between farming and local ecology (Renting and van der Ploeg 2001).

Since the 1970s there has been a countervailing societal pressure for a reorientation of agriculture towards sustainable production. The emphasis on high productivity and efficient agriculture has had to be changed to accommodate different sustainability criteria within agrarian production processes.¹ In this dynamic context several factors have contributed to the enlarged interest in farmers' knowledge. These include the discovery that such knowledge is indispensable in view of the need to re-balance growth factors, increased recognition of the significance of diversity in agriculture, and changed perceptions about the nature of innovations and innovation processes.

2.2. The need to re-balance external and internal growth factors

From Von Liebig onwards, the agricultural sciences have conceptualised and understood processes of production as the ongoing co-ordination of a wide and flexible range of growth factors, literally those factors that influence growth. Each growth factor describes an element within the production process that actually or potentially influences the yields obtainable within the process of production, for instance the quantity and composition of nutrients in the subsoil, water availability or plant variety. Together these growth factors determine the outcome of the process of production (de Wit 1992).² The upgrading of specific growth factors and the necessary adjustment of others has been the main concern of the agricultural sciences. The growth factor shortest in supply is seen to determine the level of production, whilst the utilisation of other factors clearly influences the costs.

At the same time, growth factors also include the different tasks and sub-tasks that together compose the agricultural labour process. Farm labour might be considered as the ongoing discovery and mutual adaptation of growth factors (see Figure 1). Through centuries farmers have been trying to identify the limiting growth factors and to design new farming methods in order to go beyond the known limits. From an analytical point of view, the associated farmers' innovations are characterised by several features. Examples include (1) assessing the relevance of interventions and change above all through their effects on other 'sub-systems' and/or on the level of the farm as a whole³, (2) the importance of feedback and 'feed-forward' linkages⁴. Furthermore (3) farmers' innovations stress 'what might be possible' instead on 'how things are (Kessel 1990), (4) they show the importance granted to diversity and (5) the importance of the local 'horizon of relevance'.⁵

Within the modernisation process the upgrading of certain growth factors and the adjustment of others was overwhelmingly geared towards the economic goal of maximising productivity growth. The associated 'green' revolution brought technological innovations, such as water management,

mechanisation, fertilisers and new plant varieties. These technologies and the use of external inputs, resulted in the subsequent upgrading of other growth factors and increases in yields.

At present a process is taking place in which these growth factors (and especially those related to external inputs) are playing a less important role within farm practices because of sustainability criteria. This downgrading of certain growth factors, in turn is inducing a wider set of changes within the processes of production. While some growth factors need to be downgraded, others need to be upgraded. New growth factors need to be discovered that fit the new demands of sustainability. What is required, in short, is a systematic and integral re-organisation of the production process in order to create a new balance that is both ecologically and economically sustainable. All relevant subsystems need to be reorganised in such a way that a new equilibrium is created (van Bruchem and Tamminga 1997). Both scientists and farmers need to develop insights in the specificity of the farming systems and their dynamic relations with local conditions and available growth factors (be it the subsoil and its dynamics, natural processes and contingencies, or the manure produced at the farms).

It is important to note here that in order to help realise these new societal goals, a greater emphasis is required upon internal rather than external growth factors. Local ecological conditions and locally available growth factors need to be the starting point for arriving at sustainable balances. In view of this locally specific knowledge regarding the farm and its environment acquire a new relevance. Since farmers are important carriers of such knowledge, it is not surprising that the issue of farmers' knowledge attracts more attention now than before. Experiences reported upon elsewhere in this book (see for example chapters 8 and 12) show that farmers often have a rich understanding of local resources, and that they engage in many attempts to maintain social and ecological systems. Farmers' knowledge can be a useful source in better understanding how ecosystems can and cannot be transformed, how ecosystems can be managed and how social systems might be designed to mesh better with ecosystems (Toledo 1990).⁶ For too long, however, the focus on the possibility of using and enhancing farmers' knowledge has remained hidden within the context of the prevailing dominant scientific knowledge system (see Section 2.4).

2.3 The re-discovery of diversity

For a long time agricultural scientists have assumed – implicitly or explicitly – that agricultural development is something that progresses in one particular direction (e.g. towards high input, high output and hi-tech farming). The idea was that given certain conditions there is basically *one*

optimal way of managing a farm. Much used categorisations of farmers such as 'vanguard farms', 'followers', 'early adopters', 'late adopters' and 'laggards' (van den Ban 1963; Rogers 1983) reflect this idea, namely that everybody is (or should be) moving in the same direction, even if some may do so more quickly than others. In recent years, many studies have indicated that this idea is flawed. Farms that are (initially) characterised by comparable lay-outs and household composition, and which operate under very similar conditions, can still develop along different, economically viable, paths (Bolhuis and van der Ploeg 1985). A key factor in explaining such different patterns of farm development (often labelled 'farming styles') are the diverse strategies, modes of thinking and aspirations that farmers may have *vis-à-vis* their social and natural environment. Another key factor is the diversity in the way they organise their livelihoods, including variations in the role agriculture plays *vis-à-vis* non-agricultural activities (Wiskerke 1997).

While the existence of diversity was often considered to be 'a problem' in the context of the modernisation trajectory, it is looked upon as an opportunity and challenge in the context of debates on ecological sustainability. This newly found legitimacy is due to the fact that differential farming styles can, at least partly, be understood as forms of adapting to diversity in local ecosystems. Farming styles are an outcome of *co-production*, that is the ongoing interplay and mutual transformation of the social and the technical (Law 1986), including evidently local ecosystems. In view of the adaptive nature of farming styles, understanding their underlying logic and rationale is important when the aim is to foster sustainability. And as logic and rationale are closely intertwined with cognitive processes, we see that the increased attention for diversity provides another impetus to re-examine farmers' knowledge.

2.4 *Changing views on innovation*

Modes of thinking about innovations and innovation processes have changed considerably over the last decades (both within the realm of agricultural science as well as in a broader context). In the research tradition of 'adoption and diffusion of innovations' (Havelock 1969; Rogers 1983) the basic opinion was that innovations originate from scientists, are transferred by extension agents and other intermediaries and are applied by agricultural practitioners. This mode of thinking is labelled 'the linear model of innovation' (Röling and Jiggins 1998), as it describes a straight and one-directional line between science and practice⁷. The model is further characterised by a clear task division between various actors; some actors are supposed to specialise in the *generation* of innovations, others concentrate on their *transfer*, while the farmers' role is merely to *apply* innovations (Long and Long 1992).

However, when scholars started to analyse in retrospect how successful innovations came about in practice, they soon discovered all sorts of deviations from this linear model. It appeared, for example, that researchers often got 'their' innovative ideas from practitioners and farmers made significant adaptations to the packages developed by scientists. Furthermore many innovations occurred without the involvement of scientists. The function of extension agents was not so much to transfer knowledge and information from scientists to farmers, but rather the other way around, or even to play a role in knowledge exchange between farmers (Richards 1985; Vijverberg 1997; Leeuwis 1993). In view of such findings it was concluded that innovation requires close co-operation in a network of actors, who all contribute to the 'generation' and 'transfer' of knowledge and innovations (Engel 1995). In short, farmers are also regarded as having valuable knowledge, and as being able to play an active and creative role in innovation processes.

In connection with the foregoing, the ideas about the nature and dynamics of innovation processes have also altered significantly. While the tendency was to look at innovation primarily as a process of 'scientific research' and 'discovery', scholars now tend to look at innovation as a process of 'network building' (Callon, Law *et al.* 1986), 'alignment', 'social learning' and 'negotiation' (Leeuwis and Remmers 1999). Similarly, the idea that 'an innovation' could be described in one-dimensional terms has been abandoned by many, replaced by the notion that 'an (successful) innovation' is composed of various technical and social arrangements (or 'sub-innovations') that together form a 'coherent novel working whole' (Roep 2000). When the aim is to arrive at such novel pattern of co-ordinated action, the views and perceptions (i.e. knowledge) of farmers and other stakeholders somehow need to be accessed and incorporated in a design process (see for a more elaborate discussion on innovation, chapter 2 of this book).

2.5 Further drawbacks in utility of the formal agricultural knowledge system

Current debates within agrarian research communities lead to a greater recognition of farmers' knowledge. Yet, there remains a number of, historically derived, drawbacks to incorporating such knowledge in the research activities that take place in the formal agricultural knowledge system (i.e. universities, research institutes, etc.). An overarching obstacle in this respect is that both unilinear modes of thinking about farm development and linear models of thought regarding innovation fade only slowly (or perhaps not at all) (Leeuwis 2000a).⁸

The agricultural knowledge system has always been very closely connected to the modernisation process in agriculture. In that respect one can even speak of the scientification of agriculture (van der Ploeg 1987).

Scientification is the systematic reorganisation of agriculture according to models designed within the realm of the agricultural sciences. Thus, for decades science has been about how farming ought to be instead of how it is.⁹ Basic to these models were – and often still are – widely shared normative assumptions such as: ‘Good farming is high productive farming’ or ‘Good farming is technology-driven and market-oriented’. Given its historical roots within the modernisation project, the current (formal) agricultural knowledge system is still characterised by such (often unspoken) limitations that need to be changed in view of sustainability demands.

Scientific knowledge is not responsive to societal needs

Patterns of development that did not match the modernising ideal have long been neglected and considered to be irrelevant within the agricultural sciences. The generation of scientific knowledge was not so much oriented towards existing societal practices and problems, but rather to a distant future to be reached eventually (van der Ploeg 1999). Scientists were supposed to develop blueprints for good farming. Good farmers were the ones who acted according to these blueprints. Thus, science tended to be separated from everyday farming practice and practitioners, both in terms of decision-making and implementation. Still, many structures and procedures in science, including funding arrangements for research, do not provide much opportunity for farmers and other societal stakeholders to make their voices heard and ensure that the activities of scientists are responsive to their immediate needs.

The limitations of dominant epistemologies

The epistemological culture from which most agrarian sciences still depart is one based on the proposition that one needs to ‘reduce’ complex wholes to their component parts¹⁰. The underlying premise of this approach is that by focussing on the individual parts, and the relations between isolated variables, one can understand the functioning of the complex whole. In this Cartesian view, a relevant whole (be it a cow, a field, a farm, a regional farming style) is understood as the mere *sum* of its constituent elements. Given this tradition, it has proved to be extremely difficult to come to grips with interactions at higher levels of integration – especially with those interactions that reshape or remould some of the composing elements or ‘building blocks’. In most agrarian sciences, for instance, ‘a field’ is studied as a separate unit in a research station with controlled environments (or even simulated in a laboratory or computer). That is; it is studied in isolation from the interactions between the field and, on the one hand, its wider bio-physical (including chemical, biological, etc.) environment, and, on the other, its social environment (e.g. farm labour organisation, farmer strategies, markets, etc.).¹¹ This approach, deeply ingrained in the agrarian sciences, gives rise to

particular (and often limiting) approaches to sustainability. Higher levels of sustainability are often thought of as something to be achieved through the improvement of the *partial* efficiency of the different building blocks, rather than being dependent upon new balances at higher levels of aggregation.¹² In all, the formal agricultural knowledge system is not epistemologically well equipped to look at, and/or make, sensible statements about complex wholes.

From maximising to optimising results

The production of scientific knowledge has long tended to focus on maximising results through the replication of knowledge gained from one locality (the laboratory or research station) to the others (in the case of agrarian science, the farm). What does well on the research stations in controlled environments and with easy access to input is mainly useful to those farmers whose conditions resembled those at research stations. Thus, the conditions of the research stations (or laboratory) where the research has been conducted need implicitly to be imitated.¹³ The models provided by science often fail when the farming system differs from the circumstances in which the scientific experiments are conducted.¹⁴ For these reasons, a wide range of farmers normally finds that 'experts' knowledge' is of limited practical value. (Eshuis 2001; Scoones and Thompson 1994)(.). This gap between theory and practice becomes even pronounced when sustainability issues need to be considered. Thus, a new mode of working is required that enables scientists to optimise knowledge within and for different local conditions. However, appropriate methods and approaches for doing so are lacking, or at best in their infancy.

The fragmented and scattered nature of agricultural sciences

Much agricultural research and education is organised around disciplines (e.g. soil science or sociology) and classical agricultural sectors (e.g. dairy farming and pig farming). Thus, a large number of agricultural institutions (including extension services, research institutes, university departments, educational programmes) are still segmented and organised according to these differentiation. That is; they either focus on crop farming, horticulture, dairy farming, pig farming, etc. Furthermore, academic disciplines become increasingly scattered and fragmented. Scientist have become an experts in their own field that addresses a very narrow element of agriculture; this in contrast to the approach advocated by classical agronomists (see for example Timmer 1949).¹⁵ This development makes it all the more difficult to tackle problems from an integrated perspective. In response to this we have – from the 1980s onwards – witnessed calls for interdisciplinary and/or multidisciplinary research in which different experts co-operate together on one theme (Nooij 2001).¹⁶ Also new forms of education have come to exist in which

students are trained within several disciplines. Within science, therefore, we currently see a tension between knowledge that is supposed to be all-comprehensive and the scientific practice of individual disciplines that are still hard to link to each other.

In conclusion we can say that within the formal agricultural knowledge network there is an increasing acknowledgement that farmers' knowledge is important, and that farmer induced innovations need to be given space. These insights are slowly permeating the agenda and resulting in adapted practices. Potentially, this can result in radical changes of agriculture and its knowledge network. However, the structures that have emerged from the 1950s onwards seem persistent and practical methods and approaches for moving forward are still in short supply (van der Ploeg 1999; Taskforce 2001).

3 Coming to grips with farmers' knowledge

3.1 Introduction

In this section we further explore the nature of farmers' knowledge. We discuss important characteristics. Moreover we touch on differences and similarities between scientists' and farmers' knowledge.

3.2 Characteristics of farmers' knowledge

In this chapter, farmers' knowledge is defined as the capability of a farmer to co-ordinate and to (re-) mould a wide range of socio-technical growth factors within specific localities and networks towards desired outcomes (e.g. sustainable levels of production). Evidently this capability assumes a range of experiences which allow the farmer to come at grips with the relevant growth factors and/or to discover new relevant growth factors. Furthermore the ongoing identification of unknown and unexplored growth factors underpins the dynamic nature of farmers knowledge and associated practices. Knowledge and farm labour can therefore not be considered separately.

Figure 1 illustrates the linkages between growth factors, farm labour and specific localities and networks. First, the farmer needs to make a set of decisions to rebalance growth factors. Growth factors, such as livestock, grassland, nutrients and water are evidently linked with each other. Second, farm labour involves the choice between utilising local or external growth factors (in this case the choice between fertiliser or manure, seeds or local vegetation, so on and so forth). Third, these growth factors are embedded in specific socio-material localities and networks (markets, government, landscape and technologies).

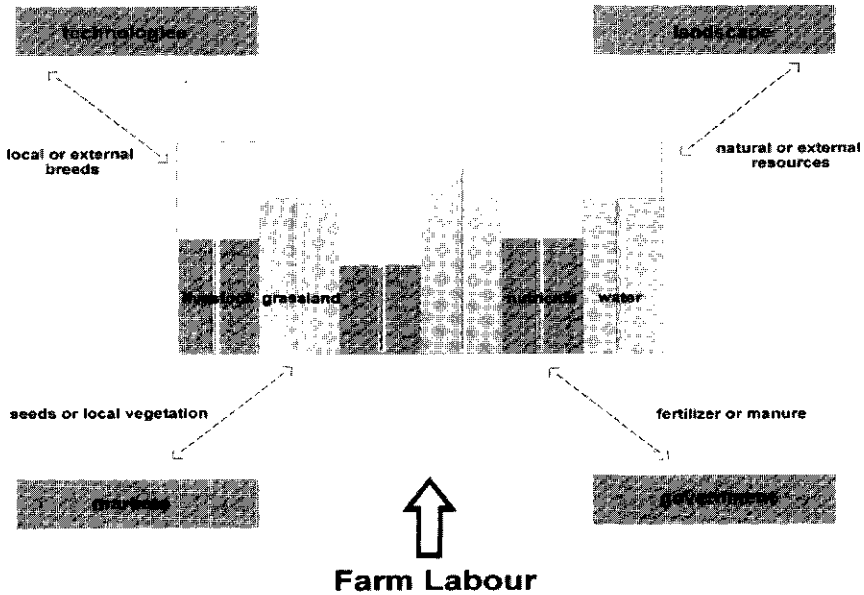


Figure 1 The co-ordination of growth factors within specific localities and networks.¹⁷

The following sections highlight several characteristics of farmers' knowledge in order to clarify its nature.

Farmers' knowledge refers to a specific local context

Farmers' knowledge incorporates elements that derive from 'outside' (e.g. from science, formal education and/or other spatial settings). Nevertheless, this knowledge needs to be meshed with knowledge that is specific to the farm and its constituent elements (e.g. fields, cows, soils, community, etc.). In other words 'universal knowledge' needs to be localised to the farmer's specific setting. This knowledge has often been build-up over generations. As Mendras (1970: 47) puts it:

'The traditional peasant tilled the field he had inherited and learned to cultivate from his father. He knew all the most minute details of the field, the composition and depth of the arable layer, which often varied from place to place, its rock, humidity, exposure, relief and so on. The result of long years of apprenticeship, work and observation, this knowledge that he alone possessed was the basis of his skill as a farmer (Mendras 1970).

Thus, farmers' knowledge involves the art of developing agriculture within local conditions and to rebalance growth factors towards these local conditions. A related term that is often coined is that of 'indigenous knowledge' (Scoones and Thompson 1994). Often farmers' knowledge is expressed in specific languages and classification schemes. Farmers, for

example, often use different words than scientists to distinguish between different categories of land, soil, plants and natural resources. One reason for this is that the criteria are different: for farmers they are related to use (Eshuis 2001). This brings us to a next characteristic of farmers' knowledge.

Farmers' knowledge is experiential and in part implicit

An important aspect of farmers' knowledge is that it is tied to action. This means that it is not just a mental capacity but also carries elements of practical and physical skill (Scott 1998). A farmer may not only have an image of how to effectively plough a particular field, but also -and in connection with this- a series of bodily skills for performing such a task with a specific implement. In connection with this, farmers' knowledge can be seen to arise from engagement in regular and/or experimental practices. In the course of time a farmer monitors and evaluates the effects of his practices and decisions. The adjustments that farmers make never end as they constantly lead to other adjustments in other domains of farming. This process is a spiral; farmers constantly adjust, monitor, evaluate and adjust again. Every time a farmer discovers that he lacks knowledge, and on the other hand he needs to deal with the changes on the basis of his available knowledge. In this way he learns by doing and does through learning. It is important to note that much of this practical and experiential knowledge of farmers may remain implicit or 'tacit' (Giddens 1984). That is; it is often difficult for farmers (or others) to express this knowledge in unambiguous rules and/or find words to express what they know.

Farmers' knowledge is about co-ordination and integration

In many ways farmers' knowledge refers to the capacity to meaningfully co-ordinate and integrates practices in different domains of farm labour. Farmers' knowledge is in part integrated knowledge as it refers to the relevant whole of different farming domains, production objects, processes and sub-processes. It centres on the different possibilities for evolving and unfolding production processes:

'...operating within as wide a range of cultivation and animal rearing as possible, integrating these into a system in which the by-products of each could be utilised to the maximum for the others' (Mendras 1970).

Simultaneously, farmers' knowledge is the art of adjusting the processes of production to contingencies and unintended effects, *'through diversified speculation, furnished security against inclement weather and uncertain harvests'* (Mendras 1970). Farmers' knowledge entails the understanding of the effects of wind, water and temperature on the processes of production. Furthermore farm labour presupposes the active interplay of the farmers with these contingencies and diversity in circumstances and outcomes.

'Every cow reacts differently to a new form of nutrient supply, with different outcomes in health, milk production and meat production. I adjust the fodder intake to these diverse reactions of the cows, but also to the available fodder, that changes with the seasons and with the harvest of grass, corn or other yields (Friesian farmer).'

On this basis we can describe farmers' knowledge as referential knowledge; farmers know their soils through the grassland production, they know the grassland through the effects on the animals, they know the cows through the manure and the manure through the grassland production.

The term 'craftsmanship' is often used to refer to the capacity to coherently integrate and co-ordinate a range of practices and the possibility to act under given circumstances or actively influence these circumstances (Baars, de Vries *et al.* 1999). Thus, craftsmanship is what an actor can do to combine several elements of the production process. It entails detailed knowledge of the necessary, and most appropriate, use of the concerned instruments and labour-objects, the locally available instruments and objects of labour. As van der Ploeg emphasises, craftsmanship is generated in an experiential manner described earlier. It entails a permanent interaction between mental and manual labour and presupposes a continuous (re) interpretation and evaluation of the process of production so as to enable intervention at any required moment and in any desired way (van der Ploeg 1993).

Finally, from Figure 1 it has also become clear that farmers' knowledge does not only include technical knowledge. Farmers' knowledge also refers to the social and the technical surroundings. It is embedded in, reflects and acts upon local and historically available socio-material resources. It is not only important for farmers to gain knowledge on the technical artefacts and the way they work, but also the way they can be aligned in the socio-material environment in which they are applied.

3.3 Farmers' knowledge versus scientists' knowledge

When comparing farmers' knowledge to scientists' knowledge some differences are immediately evident. First of all, the generation of scientific knowledge tends to take place in totally different experiential environments than the production of farmers' knowledge (e.g. laboratories, research stations and universities versus real-life farms). Moreover, although scientific action (i.e. the process of arriving at scientific knowledge) may well involve tacit knowledge and skills (e.g. laboratory work, interviewing, etc.) the scientific endeavour is all about making knowledge explicit and formal. Thus, many scientists feel they cannot suffice to keep their knowledge implicit, which poses different demands on the process of knowledge production. In connection with

this, scientists often adopt a reductionist epistemology. As we have already discussed in Section 2.4. this epistemological culture makes it difficult for scientists to arrive at knowledge of complex and co-ordinated wholes, whereas we have seen that this is one of the strengths of farmers' knowledge. In all, it is clear that the modes in which farmers generate and evaluate knowledge deviate significantly from those of scientists. Farmers tend to generate knowledge from practical experiences, and not from formal experiments and research. And even if farmers engage in deliberate experimentation, their experiments have very different characteristics from those of scientists (see our discussion in section 4). Moreover, farmers are likely to have a different form of evaluating and validating knowledge than scientists, in that they are likely to apply a much more holistic frame of reference than scientists who tend still to take a reductionist approach.

The local dimensions of scientists' knowledge

An issue that deserves some more attention is whether or not these two forms of knowledge differ with regard to their 'locally specific' character. For a long time scientists have claimed scientific knowledge to be 'universal', generally applicable and superior to farmers' knowledge. Moreover, many scientists identified themselves as 'experts' and others as 'laymen'. More recently we see that there is increased recognition that the knowledge that scientists produce is not 'universal', but has important local dimensions. That is, it is realised that the knowledge produced in scientific laboratories may be valid within the specific local conditions of the laboratory, but not necessarily in contexts that have different characteristics (e.g. a farm). Moreover, scientific endeavour is influenced and affected by specific 'local' considerations and conditions (Knorr-Cetina 1981; Latour 1987). Essentially, we see that agricultural research rather than being a series of discrete and rational acts, is in fact part of a process of coming to terms with conflicting interests, a process in which choices are made, alliances formed, exclusions effected and worldviews imposed (Scoones and Thompson 1994). Time and financial constraints, conditionality and donors influence choice of methodology. Also personal criteria play a role like habit and fear of not being respected. Methodology is political and personal (*ibid.*). Scientific propositions, claims, hunches and ideas take on the status of facts and become robust even before they have proved their universal validity (Rip 2000). In addition, it is important to realise that the questions underlying scientific investigation too often derive from a specific local context. Questions and problem definitions are never neutral: they are asked and/or funded by specific stakeholders, for a specific reason, and in connection with specific goals and interests.¹⁸ The above implies that even if, within the parameters of a well-defined context and conceptual framework, natural scientists can claim to arrive at, at least temporarily, valid or 'objectively true'

conclusions, they cannot claim to arrive at *neutral* conclusions. This is because the conclusions arrived at are more often than not directly linked to the (research) questions that were asked.

In view of these considerations we prefer not to use the conventional distinction between 'scientific' and 'local' knowledge from hereon, but speak simply of scientists' versus farmers' knowledge. Since all knowledge is contextual by nature, the term 'local' can not be used to make a distinction. Scientific knowledge is also bound to locality, even if it is presented to be universal knowledge (Lash, Szerszynski *et al.* 1996; Leeuwis 2000b).

Arguing that scientific knowledge tends to be valid in a specific locality certainly does not imply that conventional natural science research has nothing to offer to farmers in specific contexts. In fact, current farmers' knowledge may well incorporate elements that derive from scientists in one way or another. Moreover, much of the existing farmers' knowledge needs to be renewed, adapted and supplemented because of rapid contextual changes that take place (e.g. population growth, migration, climate change, industrialisation, ecological changes, globalisation, degradation, etc.). And farmers' experiments and knowledge do have certain strengths, but also a number of weaknesses, and therefore tend to leave a number of questions unanswered. In some cases conventional (positivist and reductionist) laboratory research can provide extremely valuable 'building blocks' for solving farmers' problems. In short: there is nothing wrong with conventional (applied or fundamental) research, as long as it answers the relevant questions (Leeuwis 2000b). Much of the critique of conventional scientific research, then, boils down to the assessment that it tends to operate in isolation from real-life innovation processes, and generates its own questions rather than addressing the questions and specific problems that societal stakeholders find relevant. Hence, the frequent plea to make agricultural science more interactive (Röling 1996). In view of the above, we currently witness several efforts to arrive at new epistemological approaches that transcend the old dichotomy of the 'scientific' and the 'unscientific' (Röling 2000). In the next section we suggest some practical ways in which scientists and farmers may benefit from each other in developing sustainable agriculture.

4 Gaining farmers knowledge, experiences and insights

4.1 Introduction

We have argued so far that farmers' knowledge, experiences and insights can be an important resource for the sustainable development of farming systems as well serve as a resource for (interactive) scientific research. The aim of this section is to explore various ways in which farmers'

knowledge can become more robust. First we will investigate how we can make farmers' knowledge more explicit. Second we will describe methods to enlarge farmers' knowledge. Third we analyse means to use farmers' knowledge as a resource for scientific purposes.

4.2 Making farmers' knowledge, experiences and insights more explicit

We have seen in Section 3 that farmers' knowledge tends to be partly implicit. This is true of several aspects of farmers' knowledge. First, practical knowledge concerning rebalancing growth factors and the interrelations between growth factors on the farm is often implicit. Finding new indicators for recognising and discovering growth factors that are now implicitly present can therefore be important. Second, specific farming practices that support the rebalance of these growth factors may not be immediately visible and/or explicit.¹⁹ Third, in addition to the explication of technical growth factors, there is often a need to make their socio-economic alignment more tangible. One can think about forms of labour organisation, contracts between farmers and government or the development of regulations and technologies. Frequently, such socio-organisational dimensions of innovations are overlooked, although farmers have a lot of knowledge and ideas on these matters. Thus, a first strategy for collecting and capitalising on farmers' knowledge is to make it more explicit and recognisable. This includes explicating farmers' uncertainties, knowledge gaps and research questions, as these too can be seen as expressions of knowledge. In relation to all this, several basic strategies may be of use.

Recording experiences

A first strategy to make implicit knowledge more explicit is to stimulate the development of reflective routines. There are impressive examples of farmers who have their own methods of collecting experiences and impressions (van der Ploeg 1999). Farmers continuously experience things, but do not always record them. Simple notebooks or pocket tape recorders are amongst the devices that farmers can (and do) use to memorise and store their thoughts while going about their daily work.

Creating opportunities for (group) discussion

An important strategy for making knowledge explicit is to encourage farmers to talk about their knowledge, ideas and experiences. This may happen in a one-to-one interview situation, but useful insights may also be elicited from group discussions. Thus, one may, for example, bring farmers together in a group to talk about certain issues and problems. These kind of discussions can contribute making implicit knowledge explicit, helping to fill in the blind spots of what is not (yet) known and simultaneously improving awareness self-consciousness of what is already known.

Farm comparison

Group discussions can be aided greatly by encouraging forms of farm comparison. Through observation of several farms and farm practices differences can be noted between one's own farm and those of others. This can pose mental and interpretative challenges, which in turn encourages debate whereby underlying views and rationales may become more explicit. More generally, it helps farmers to take a fresh look at the existing processes on their farm. Farm comparison can take place in various forms and incorporate farm visits and excursions as well as systematic (possibly computer supported) collection, exchange and analysis of information from different farms (Leeuwis 1993).

Scientists who want to discover farmers' knowledge through supporting these kinds of activities may usefully play a double role. They can bring their own expertise on the specific areas in order to stimulate (not dominate) debate and they can act as facilitators in the discussion. The role of facilitator needs particular attention, as farmers can bring much expertise when scientists are able to skilfully facilitate this process (Baars 2001). As scientists are trained in the analysis of problems they need to take a modest role in this role, in order not to override the analysis of the farmers. Scientist's role in the facilitation of discussion should focus on promoting the need and methods for joint investigation, enhancing the strategies for experiential learning and giving space for feedback.

4.3 Enlarging farmers' knowledge, experiences and insights²⁰

In the discussion on how to make farmers' knowledge explicit we have already touched upon the issue of how to enlarge farmers' knowledge. Indeed, one could argue that by making knowledge explicit the learning process has started and the enlargement of knowledge is already taking place. Nevertheless, it is relevant to differentiate between the two processes because the process of making knowledge explicit requires, in part, different methods than are used when enlarging knowledge. Moreover, making knowledge explicit involves discussing practical or tacit knowledge, while enlarging knowledge implies a step further in the learning process. Frequently, the enlargement of farmers' knowledge is associated with 'farmer experimentation'. We therefore turn to discuss the specific nature of farmer experimentation, and how it may be supported. In doing so it will become clear that supporting farmer experimentation also requires elements of explication; this underlining our earlier observation that 'explication' and 'enlargement' are closely intertwined.

Farmers often already engage in 'experimental' activities, even if this may not be immediately clear and visible to outsiders. Often farmers do not refer to their activities as 'experiments' or 'trials'. Perhaps more importantly, farmers' experimentation can take many forms, which

usually deviate to a large extent from the ways in which scientists think about experiments. This relates to the issue of different epistemological cultures. In connection with this, scientists may well fail to recognise farmer experimental activity. Let us discuss various important characteristics that farmers' experiments may have in this respect:

Different horizons in comparing treatments.

Farmers do not always 'run' different experimental 'treatments' (including a control treatment) simultaneously. Instead of comparing simultaneous treatments (as scientists usually do), they may well compare different 'treatments' over the years. And instead of having their own 'control treatment' they may well use other farmers' farms and practices as a point of reference. Thus, farm comparison is, in many ways, a form of farmer experimentation.

Ex-post reconstruction.

In connection with the above, farmers' experiments – unlike scientists' experiments – are not necessarily designed deliberately and planned prospectively. Experiences may well become constructed *as* experiments in retrospect. By comparing one's own practices and results with those of others or from previous periods, for example, one can come to think about observed differences as the outcome of an 'experiment' (see Baars 2001). Similarly, experiments may happen accidentally, for example when two household members carry out the same task in a slightly different way, or when two fields are handled in the same way, but at a different point in time.

Experimentation as improvisation.

Although farmer experiments may often be carried out from sheer interest, farmers may sometimes also be 'compelled' to engage in 'experiments' in the face of external conditions, such as the non-availability of inputs used normally. Here, experimentation takes the form of improvisation.²¹

Multiple 'independent' variables.

Farmer trials do not usually take place under controlled conditions but take place in the context of wider farming activity. Due to both the carefully co-ordinated nature of farming practices, uncontrollable conditions, and the different horizons of comparison that farmers may apply, there are usually several 'independent' variables at the same time (whereas scientists often prefer to isolate *one* independent variable). This is especially true when the horizon of comparison is a previous year. When, for example, a farmer tries out a new maize variety there will usually be more relevant differences (e.g. weather, sowing dates, etc.) with previous years than just the variety used.

Holistic evaluation and measurement.

Even if scientists do consider several 'dependent' variables when evaluating an experiment, farmers are likely to take into account an even wider range of 'variables'. In a fertiliser experiment, they may not only evaluate 'yield', 'cost effectiveness' and 'pest-infestation', but also 'taste', 'marketability', 'crop-residue', 'labour demand', etc. Moreover, while scientists usually prefer precise measurement of variables, farmers may also use less tangible (i.e. tacit) modes of evaluation, such as impressions, intuitions and feelings (Eshuis 2001).

In view of the above we can conclude that it is perhaps better to speak of farmers' *experimental activities* rather than of farmers' *experiments*, as the latter term suggests a degree of deliberateness and demarcation that is misleading. Nonetheless this does not weaken the importance of the activities as learning experiences.

Modes of supporting farmer experimental activities to enlarge knowledge

In our view, supporting farmers' experimental activities should not be equated with 'turning farmers into scientists' or 'imposing scientists' epistemological culture'. Knowledge creation may have a rather different meaning and purpose for farmers than for scientists. For instance, it is often impossible and/or inefficient for farmers to wait to explore new practices until scientists are fully convinced of their efficacy. They may want, and need, to 'go ahead' when they have sufficient evidence that something 'works', even if such evidence does not live up to scientific standards. Rather than replacing current modes of investigation and farmer research, the support of experimental activities could build on existing practices in various ways:

Explicating and exchanging existing experimental activities

Many of the existing experiences may not yet have been explicated and shared among farmers. Hence, identifying, collecting and exchanging existing experiences may contribute much to problem solving and innovation (see Section 4.1).

Improving measurement, memory and feedback

Often the capacity to draw inferences from experimental experiences can be enhanced by adapting modes of measurement, and by the collection and storage of information about regular and experiment-like activities.

Supporting interpretative debate in groups:

Due to the nature of farmers' experimental activities, it is often not easy to draw clear conclusions, as there tend to be a number of possible explanations for certain phenomena. One way of improving the capacity to draw valid conclusions is through talking with people that have similar

experiences. Here too organising group discussions around such experiences can be of use.

Identifying issues and adding options for deliberate experimentation

Outsiders can organise group debates and analytical activities that are geared towards identifying areas that require experimentation. Forms of joint socio-technical problem analysis and priority ranking can be of use here. Moreover, outsiders can be useful in suggesting new options and opportunities for experimentation and/or providing farmers with insights that lead them to adapt their research agenda (Veldhuizen, Waters-Bayer *et al.* 1997). Agricultural innovations frequently emerge from accidental experiences or from experimental activities that neither farmers nor scientists considered very promising initially. Therefore it may be useful not only to think about 'the obvious' but also to solicit and seriously consider 'crazy' and/or unconventional ideas and solutions.

Including social-organisational 'experiments'

Very often the focus on on-farm experimentation is solely on technical experiments and issues. Given the experience that innovation requires new social-organisational arrangements as well this is a rather one-sided approach, which may well lead to technically sound solutions that can never be applied. Thus, in many instances it can be relevant to experiment with (or work towards) alternative social-organisational arrangements as well. More so than with technical experiments only, such alignment activities may exacerbate social tensions, and hence requires efforts to facilitate conflict resolution.

Debating the design and management of deliberate experiments

When making plans for new on-farm experiments, the design of such experiments is obviously an area for discussion with farmers. Without necessarily imposing scientific modes of experimental design, scientists' concerns and insights on systematic experimentation may still serve as inputs in such a discussion. Sometimes small changes in the design of farmers' experiments can lead to a considerable increase the potential to draw accurate conclusions. In this context it is pertinent to discuss where to conduct, and how to administer, experiments. It may be important to consider that one need not necessarily arrive at one single design or location. It can be enriching to make use of the existing diversity in farmers' preferences and views, and run several on-farm experiments at the same time.

Reducing risks

Sometimes potentially interesting experiments go along with prohibitive (perceived) risks and uncertainties. Farmers may, for example, be wary of experimenting with reduced use of pesticides, due to fear of losses in yields. In such cases, outsider agencies may provide insurance and

resources that allow farmers to experiment and reduce their risk. One form of protection that farmers need can be *vis-à-vis* each other. Scientists can play a facilitating role among farmers when the experiments they are doing are not clear to one another and may possibly cause problems within the farming community.

Co-ordination and interaction with formal research

It is recognised that on-farm experimentation and research in formal scientific research institutes can fruitfully enrich, inspire and complement each other (Baars, de Vries *et al.* 1999; van Schoubroeck and Leeuwis 1999). In general, carrying out similar experiments in several locations tends to lead to different experiences and serendipitous discoveries. Moreover, formal on-station research can provide a back up to on-farm experimentation in several ways. Farmer experiments may 'fail' due to a variety of reasons (related to natural conditions, technical practices or socio-organisational issues) and comparison with on-station research may at times provide clues about such reasons. Moreover, formal research facilities often allow for more in-depth exploration of underlying mechanisms, provide some 'free creative space' for scientists to follow their gut-feelings and intuitions, and allow for more rigorous and frequent data collection. As van Schoubroeck (1999) indicates, complementarity is more easily achieved when the same persons are involved in both on-farm and station research.

4.4 Use of farmers' knowledge as a resource in scientific endeavour

In addition to supporting farmer experimentation, scientists can use farmers' knowledge as a resource for their own research. One often-practised method is by treating farmers, their practices and knowledge as *objects* of research. The role of farmers is very often limited to this, which implies that they are not actively involved in the design of the research or in analysing its results. In this section we explore some relevant issues for consideration when including farmers as equal partners in scientific research.

Choosing partners

An important aspect when one wants to engage farmers in research is the selection of the right partners. Very often this selection is the same way as when selecting research colleagues or partners. Farmers with an interesting worldview, interest and expertise can enrich the contents and meaning of new research. One could call these farmers 'pioneers', who are interesting to have as partners in research. Also farmers who have specific questions can become partners in experimentation, although a selection of the questions with respect to relevance is always needed. The ways in which to involve partners can differ. One may organise and facilitate group discussions among farmers, speak and experiment with

farmers individually, or have group meetings in which both scientists and farmers participate simultaneously.

Different roles for farmers

In designing a research agenda, farmers should be involved from the outset as in this way they come to 'own' (and feel that they own) the research agenda. Furthermore, farmers can play different roles in the research process. Farmers can take a look at the research proposals and comment on the relevance and validity of the research questions and design. Moreover, one can use the hypotheses of farmers in scientific research or allow oneself to be inspired by the questions farmers ask themselves in their farming practice. Depending on the nature and the layout of the research, one can incorporate the farmers' observations by actively searching, monitoring and observing together with farmers. Do they see the same things as you or are their observations different and for what reasons? What are the ways in which a farmer collects experiences and insights and how does it contribute to science and *vice versa*? In this way both parties can find the blind spots and enrich each other in their farm and scientific practices.

Contextualising knowledge within research processes

If farmers' knowledge is to become incorporated into research agendas, close attention needs to be paid to the contextualisation of the research process and the knowledge involved. Often, scientists consult farmers for specific observations and questions, but in the translation to research, the contextuality of these observations and questions becomes obscured. Yet, this contextuality (or local horizon of relevance) can give great opportunities for innovative research, as farmers try to find ways to innovate, starting from their local opportunities and constraints. When one wants to involve farmers throughout the whole research process their strategies to search for ways within their own farm practices needs to take a central role in the research agenda.

In all, there is a myriad of ways in which farmers can be involved in scientific endeavour, and the 'optimal' way of involving farmers may vary from in different contexts. It is important to recognise that involving farmers in scientific research is quite different from scientists becoming involved in farmers' research, even if complementarity between the two may be forged.

5 Final considerations

We have spoken a lot in this chapter about knowledge. However, it is important to recognise that sustainable innovations do not come about through (farmers or scientists) knowledge alone. In our discussion of about changing views of innovation, we have emphasised that innovation

requires network building, learning, coalition building and negotiation in order to arrive at new forms of co-ordinated action. Thus, arriving at sustainable innovation is in many ways a political process, and it is in this context that knowledge plays a role. Indeed knowledge and learning can contribute to coalition building, political claim-making and conflict management. But it is clearly only one of the ingredients for arriving at new social and technical arrangements. Moreover, placing knowledge in this context underlines once more that various types of knowledge need to be accessed and acted upon during (the management of) innovation processes. These include substantive knowledge, knowledge about stakeholders and knowledge on process dynamics and/or management. In this chapter we have tended to focus on substantive (social and technical) knowledge.

In concluding, we want to recall that we have identified a number of problems with current agricultural knowledge systems (see section 2.4). Analysis of these suggests that it is far from self-evident that scientists can or want to take on board the practical suggestions we have put forward. In many scientific institutes there is ample room for scientists to include farmers' knowledge in a meaningful way. In order to facilitate the inclusion and development of farmers' knowledge these institutions may need to reposition themselves in terms of their scientific culture and organisation, including epistemological beliefs and reward structures within the scientific community. We have signalled that scientific epistemologies and views on scientific knowledge are slowly changing. It is becoming more widely acknowledged that scientific knowledge does not represent *the* objective truth, but can be more accurately described as a model that is accepted by the scientific community in a certain temporal, spatial and social context. However, while this view of science may be more widely accepted among scientists themselves, it is not so often expressed when scientists communicate with the outside world. Internal tensions within the scientific community tend to be shielded from the outside world and conflicting views and controversies tend not to be brought out into the open. One challenging aspect of engaging more with farmers' knowledge is that the 'social' construction of all forms of knowledge is made more transparent to outsiders, and that it becomes clear that scientists are actively engaged in this process.

Finally it is crucial that societal relevant research becomes something that scientists can derive status from. This may well require an adjustment of current reward structures in science. In addition to evaluation on the basis of publications in established journals (which currently dominate peer evaluation of scientific endeavour) other scientific products, such as the participation in farm developments, engagement in projects, or writing for farmers' magazine, etc.) need to be incorporated in evaluation and

assessment systems. In this way scientists' accountability towards society can be enhanced. Moreover, financial streams in the scientific community may need to be re-directed so researchers can effectively obtain resources for interactive research with farmers.

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Notes

1 This was due to the fact that new actors emerged that influenced the agenda of the agricultural policy community, for instance animal welfare, nature, and environmental organisations.

2 The relation between a yield (for instance milk production) and one growth factor (for instance protein) is not a linear one. In practice the whole set of growth factors determines the production process, being the limiting growth factor in this respect strategic (see de Wit 1992).

3 This knowledge was often obtained indirectly through observing interactions with other growth factors. Thus the benefits of using manure were known indirectly, through its effects on grassland production. The composition of different grassland varieties was known through its effects on milk yield and cattle health. The quality of milk was known through the cheese making process. Knowledge was based on the *interactions* that emerged at different levels of aggregation.

4 As a consequence, knowledge and practice are intertwined and therefore cannot be separated. We will come back to this issue in section 3.

5 An innovation that might function well in certain circumstances might be useless in other situations, precisely because the conditions under which it can be applied do not exist, and cannot readily be created.

6 But, farmers' knowledge is not always in harmony with nature, it can cause serious degradation. Farmers' knowledge should therefore not be confused with environmental friendly knowledge. The romantic assumption that people's achievements logically result in agro-ecological wisdom runs the risk of ethnocentrism (see Hobart, 1993).

7 In connection with this, Chambers (1989) speaks of the Transfer of Technology approach.

8 Leeuwis (2000) has argued that commercialising knowledge and new financial arrangements such as 'output financing' may -perhaps unintentionally- contribute to a resurgence of these linear modes of thinking.

9 'Agriculture' as represented by agricultural sciences was not in the first place the representation or expression of specific empirical farming practices, but became first of all the outcome of models.

10 For instance the development of genetically modified crops.

11 At the level of everyday knowledge, however, it is quite evident that a field is not just a particular and relatively stable point within a multi-dimensional space defined by chemical, physical and biological dimensions. A field is worked and reworked, fertilised, drained and/or irrigated, trodden on and taken care for. That is, it is transformed, through time, into what it is (see Mendras, 1970).

12 A typical example is the endeavor to raise sustainability at farm level through an accelerated increase of milk yields per cow (see chapter 7 in this book).

13 In other words, the farmers who followed the models of science profited the most of the results of science. Here we see that science reshaped the locale in a fashion that allowed their artefacts to work (Long and Long 1992).

14 This has been called the yield gap: where farmers did not get the yield that was obtained at research stations this resulted in constraints in farming systems research (See Chambers, 1989).

15 Agricultural scientists from before the modernisation of agriculture seemed more able to combine and integrate elements of (nowadays) different disciplines within their academic practices.

16 E.g. within Wageningen University and Research Center there are special funds for 3I-research; interactive, innovative and interdisciplinary research.

17 The unlabelled bars represent other (here) not mentioned growth factors.

18 Leeuwis with van den Ban (2003) gives the example of a director of a fertiliser industry who might want to know what combination of fertilisers can best be applied (when, in what dosage, etc.) in maize production in a region of Tanzania. Local farmers however, may be more interested in developing a cropping system that minimises the use of chemical fertiliser. Thus, we see that different stakeholders might ask different questions, set different priorities, and hence are bound to arrive at different conclusions. However, it is clear that -in this case- the director of the fertiliser company may well be in a much better position (i.e. may have more access to relevant resources) to effectuate his research interests than local farmers

19 We want to give an example from the mineral project of the environmental cooperatives Vel and Vanla (see section 2 of this book). Within the project, internal growth factors associated with natural manure, roughage and soil have gained new importance as the use of external growth factors, like nitrogen fertilizer had to be decreased. Still, farmers need to find ways to discover these items. Some of the farmers already have found indicators to understand these growth factors, for instance through the observation of the cattle, the characteristics of the soil or roughage. One can learn from this example that farmers may also use less tangible (i.e. tacit) ways, such as impressions, intuitions and feelings to come to indicators, as smell of the manure, the way hay feels in the hand, humidity and so on. They also found new ways to integrate these growth factors in their practices. Making their findings explicit can result in knowledge that serves as a resource for other farmers and scientists.

20 This section is based on the draft version of Leeuwis with van den Ban, 2003.

21 By way of example, the founders of Rachel's Dairy, now the largest organic creamery in Wales only started processing their milk as a result of heavy and prolonged snowfalls, which stopped milk collections for some time. Thus the seeds of a major business were sown by the reluctance of the owners to pour milk down the drain that couldn't be collected or stored (Nick Parrot, personal communication).

5 The VEL and VANLA Environmental Co-Operatives as a Niche for Sustainable Development

Marian Stuiver and Johannes S.C. Wiskerke

Introduction: the birth of the environmental co-operatives

The modernisation paradigm has, for many years, dominated the shape and direction of Dutch agriculture. This resulted in the prevalence of the agro-industrial model, characterised by industrialisation, productivism and economies of scale (see Marsden 2003; van Huylenbroeck and Durand 2003; Wilson 2001). In the last decade an alternative competing rural development paradigm has emerged. These two different paradigms co-exist, compete and evolve at different levels: in farming practices as well as in policies and sciences. The emerging rural development paradigm not only entails a new approach to agricultural and rural development practices but also calls for a new approach to scientific practices and policy making, steering and control. Key elements of this approach include regional diversification of rural policies and citizens' and stakeholders' participation in science and policy making. The emergence of the rural development paradigm was induced by a growing societal concern over the negative side effects of the modernisation paradigm. Examples of these side effects include environmental pollution through the excessive use of chemical fertilisers and pesticides and increasing dis-connections between agriculture and its social and ecological environment.¹

Environmental co-operatives in the Netherlands are part and parcel of this new rural development paradigm. In this chapter two environmental co-operatives are examined: Vereniging Eastermar's Lânsdouwe (VEL) and Vereniging Agrarisch Natuur en Landschapsbeheer Achtkarspelen (VANLA). These are located in the Friese Wouden (the Friesian Woodlands)² and were founded in 1992 being among the first environmental co-operatives in the Netherlands.³

An environmental co-operative is a regional organisation of agricultural entrepreneurs, often working in close collaboration with other rural stakeholders (e.g. environmental organisations, local authorities, animal welfare groups and citizens). They aim to integrate environmental,

conservation and landscape objectives into their farming practices. This is done in a pro-active way and from a specifically regional perspective. Environmental co-operatives are both a symbol and an expression of a new contract between local, regional and national authorities and farmers. As such, they are a promising example of new rural development practices and new forms of rural governance (van Huylenbroeck and Durand 2003).

The emergence of the environmental co-operatives was closely linked with the emerging tensions between the Friesian farms and the prevailing agro-industrial model. Intensification and scale enlargement seemed to be the only possible routes for development. The farmers in the Friesian Woodlands worried whether they could maintain their small-scale farms in the unique landscape if they did not follow this path of intensification of production and scale enlargement.

'Many dairy farmers in our area used to farm relatively extensive and on a small scale, which fitted with the landscape. Farming in a small-scale landscape is labour intensive, which means that production costs are high. As there is a growing pressure for us to farm with low production costs, the space we can give to landscape and nature gets smaller' (Local farmer quoted in Renting 1995).

Furthermore, they experienced the growing tension between agricultural production on the one hand and nature conservation on the other hand. From the 1980s onwards, the Dutch government issued a series of environmental rules and regulations designed to reduce the environmental impact of agriculture. The farmers found the regulations on environment and nature conservation both inadequate and inappropriate. Through the establishment of the environmental co-operatives the farmers hoped to be able to create more room for self-regulation in order to develop locally effective measures to reach environmental objectives:

'The new rules for sustainability were seen as difficult to implement, badly balanced and contradicting each other' (Renting 1995).

'The environmental co-operatives see the governance of nature, landscape and environment as their responsibility. They can fulfil this role by negotiating with the land users and by co-ordinating the tasks that need to be done. External control by government organisations or nature organisations can, in this way, be limited to formulating clear aims. Farmers retain choice of the methods through which nature, landscape and environment objectives are met' (Renting and de Bruin 1992).

In this chapter we discuss how the environmental co-operatives and their members have integrated agricultural production, nature conservation and landscape maintenance. However, in order to emergence of environmental co-operatives, we discuss the institutional context of Dutch

agricultural and environmental policy-making.⁴ Next, we describe the nutrient management programme of the VEL and VANLA in more detail. We conclude this chapter by synthesising our findings. We propose that the activities of the VEL and VANLA can be seen as an example of a so-called niche in which the transition towards sustainable agriculture has been able to develop.

Agro-environmental policies and policy-making in the Netherlands

Introduction

In this section we outline the environmental crisis in Dutch dairy farming and the policies that emerged as a response to this crisis. We will argue that for a long time the development of environmental policies was hindered by the corporate structure of relations between politics and farmers' organisations (see Box 1). The rules that were developed by the government were mostly focused on means, and not on targets, and were perceived by farmers as being inconsistent. When a move was finally made towards integral policy making (through the introduction of the Minerals Accounting system – MINAS) the government also maintained the other rules. Thus the government prescribed both the rules on targets as well as the means that farmers had to use to meet these targets.

The environmental impact of livestock production

In the second half of the twentieth century the environmental problems associated with the large number of livestock in the Netherlands have increased tremendously. Between 1950 and 1990 the number of cows doubled, the number of chickens quadrupled and the number of pigs increased sevenfold. Intensive animal husbandry, with its high use of fertilisers, manure and animal feeds has caused severe environmental side effects. Emissions of nitrogen (N), phosphate (P) and potassium (K) have created environmental burdens that have taken several different forms. Excessive Nitrogen use can lead to accumulation of nitrates in the groundwater, creating health risks. In almost 40 per cent of the agricultural area, the nitrate content of the upper ground water exceeds the 50 mg/l specified in Directive 91/676 (van der Bijl and Oosterveld 1996). Nitrogen is also an element of ammonia, one of the causes of 'acid' rain, which damages forests and ecosystems. In the Netherlands Ammonia is the main element of acidifying deposition: since 1980 it has contributed 45-50 per cent of total acid depositions. In 1995, some 34 million Euro were being spent annually to combat the effects of acidification and eutrophication of nature reserves (Anon. 1995a). Phosphates accumulate in the soil, and when the soil is saturated, can leach into ground- and surface water. About 400.000 ha of the sandy soils (50%) in the Netherlands are considered saturated with phosphates In

1990, agricultural emissions contributed between 21 per cent and 67 per cent (average 29 per cent) of the phosphate burden of surface waters in the different regions of the Netherlands. Acceptable surface water concentrations of phosphorus were exceeded at 75 per cent of test locations (Anon. 1995b). Leaching of nitrogen and phosphate results in eutrophication of surface water and pollution of ground water and has severe consequences for drinking water catchment areas. Overall, agriculture is estimated to be responsible for around 32 per cent of the acid depositions in the Netherlands. In 1995 the total direct costs of eutrophication and acidification caused by agricultural emissions were, if policies remained unchanged, predicted to run to 220 to 290 million Euro per year by the year 2000, rising to 500 million Euro per year by 2015 (Anon. 1995a).

On denial and obstruction

From the 1970s onwards, societal pressure to reduce environmental problems in dairy farming has increased. As early as the 1970s, research reports from the National Institute of Soil and Fertiliser Research and the Institute for Soil Fertility indicated the negative side effects of the excessive use of manure on agricultural soils (Bloemendaal 1995). From the mid-1980s onwards the Agricultural Policy Community could no longer ignore these signs (see Box 1; see also Frouws 1993; Proost 1994; van der Bijl and Oosterveld 1996). The first restrictions on production growth were introduced for environmental reasons in the 1980s after years of denial of the problems, obstruction of research and political struggles by the members of the Agricultural Policy Community (Bloemendaal 1995).

Frouws (1993) argues that the lack of anticipation of these environmental problems by the Agricultural Policy Community can be traced back to the corporate structure of the agricultural sector. The mutual interests of the APC created a status quo among its members. Furthermore, the closed character of this agricultural 'bastion' led to an attitude of denial of environmental problems. The ruling modernisation paradigm created a 'blindness' to the negative side effects of agricultural policies, especially amongst farmers:

'For a long time, environmental problems were experienced by farmers as a problem of the government. Both the government and farmers' organisations failed to clarify the consequences of individual farmer's practices for the environment. As a result, environmental problems were never internalised as being the consequence of one's actions. Creating awareness has been ignored in the policy development process' (Oerlemans and Wiskerke 2000).

Box 1 The Dutch Agricultural Policy Community

The concept of 'Agricultural Policy Community' (hereafter referred to as the APC) is used as a shorthand for the complex of stakeholders, relationships, policy processes, roles and objectives in the agricultural arena. In the Netherlands a corporate organisational structure has dominated the agricultural policy process for almost forty years. Some authors refer to the APC as the 'Green Front' (Frouws 1993; de Bruin 1997). According to Frouws (1997) members of the APC were leading farmers' representatives, experts from the Ministry of Agriculture, Nature Management and Fisheries (hereafter referred to as Ministry of Agriculture), the Agricultural Board and other corporate bodies in agriculture as well as members of the Parliamentary Committee on Agriculture. Members of the APC shared a common and firm belief in technical progress and modernisation. While contacts between the members of the APC were very close, liaison with the 'outside world' was rare. For instance, it was not until the 1980s that the APC came to consider regular contacts with the Ministry of Public Housing, Spatial Planning and Environment (hereafter referred to as Ministry of Environment) to be useful.

The corporate organisational structure was based on the 'Landbouwschap' (Agricultural Board), which was established in 1954. In this board, the three national farmers unions and unions of farm labourers were represented. Until 1995, the Agricultural Board was both a platform for negotiation and a legislative body. In the latter function the Board was entitled to levy taxes and to implement rules and regulations. The Agricultural Board was the major negotiation partner of the Ministry of Agriculture. The organisations participating in the APC were granted the privilege of influencing public policy-making in exchange for their co-operation, the legitimisation of negotiated policies and maintaining discipline within their constituencies. Frouws (1997) states: *'This neo-corporatist exchange was ruled' by a permanent search for consensus, elitist decision-making, membership passivity and isolation vis-à-vis non-agricultural 'outsiders'. The APC was like a state within a state and the 'Landbouwschap' functioned as the 'farmers' parliament.'* The corporate structure worked effectively when the Ministry of Agriculture and the agricultural sector shared the same modernistic view of agricultural development: based upon a highly productive, efficient, export oriented agriculture, requiring farm enlargement, specialisation and intensification.

Frouws and van Tatenhove (1993), Termeer (1993) and Bloemendaal (1995) all conclude that this denial and lack of anticipation of environmental problems was maintained for a long time because of the limited interaction between the APC and other outside actors. In addition, relevant actors outside the APC (i.e. environmental groups) were less organised (Frouws 1997).

When the Dutch government began to develop agro-environmental policies in the early 1980s to prevent a further expansion of livestock production, farmers found it difficult to understand the change in the attitude of the government. Oerlemans and Wiskerke (2000), quoting a

representative of the Dutch Agricultural and Horticultural Organisation illustrate this:

'For years, the government was investing millions of guilders in developing the agricultural sector to internationally competitive production levels by stimulating growth and expansion. And now they turned their back to the sector by stating 'you have got a problem'. It is hard to explain this change of attitude to our farmers. (...) It is common knowledge that people pass several phases when being confronted with a problem. First, they deny the problem, after some time they accept that there actually is a problem and it's only some time later that they change their attitude and take action to solve the problem. The whole agricultural sector has been living in the phase of denial for a long time. Now it's slowly changing towards the acceptance phase.'

A never-ending story? The development of manure and nutrient policies

The introduction of the Milk Quota System in 1984 became a turning point in the intensification of Dutch agriculture and was followed by the introduction of the Interim Pig and Poultry Holdings Act. This act tried to restrict the rapid growth of intensive pig rearing and poultry farms. The Minister of Agriculture prepared and implemented this act without prior consultation with the Agricultural Policy Community. Though this act never achieved its aims of putting a hold on the growth of pig holdings, it opened up the discussion on the negative consequences of intensification and production growth processes during the former decades. The Act also led to joint actions between the Ministry of Agriculture and the Ministry of Environment. They co-operated with each other in the design of the Fertilisers Act (which was initially the responsibility of the Ministry of Agriculture) and the Soil Protection Act (which was the primary responsibility of the Ministry of Environment). Environmental issues thus gained a new importance on the political agenda, partly due to a stronger environmental lobby and a higher profile in public opinion (de Bruin 1997). As a result the influence of the Ministry of Environment on agro-environmental policy increased.

From the 1980s onwards, a new series of agro-environmental policy measures was introduced. The main reason for new and additional policy measures was the growing anxiety, both nationally and internationally, about the dangers of groundwater pollution (de Walle and Sevenster 1998). A phased approach was adopted in order to give room to the agricultural sector to adjust their practices and for the Ministries of Agriculture and Environment to develop and fine-tune their policies. There were three phases, each of which had a distinct objective:

- 1 Stabilisation of manure production at a level where all manure produced could be utilised nationally, to prevent a national manure surplus (1987-1990);

- 2 A steady reduction of the nutrient surplus through the gradual tightening of standards for the application of manure and fertilisers, to avoid further accumulation of nitrate in soil and water (1991-1994);
- 3 Achieving equilibrium between inputs and outputs of nutrients (1995-2000).

According to Henkens and van Keulen (2001) the phased approach was built upon two lines of government intervention: application policies and volume policies.

- 1 The application policies. The Decree on the Use of Animal Manure, which was based on the Soil Protection Act, regulated the application of manure between 1987 and 1998. It specified restrictions on the annual dose of animal manure (i.e. the application standards) as well as the timing and methods of application (such as the obligatory slit injection of manure, see below). The application rates, calculated on the phosphorus content of manure⁵ were decreased through time in order to diminish the environmental impact of phosphorus and nitrogen
- 2 The volume policies. Regulations regarding manure production initially aimed to halt the expansion of the livestock sector and thereby the increase of manure surpluses at national level. This started, as mentioned before, with the introduction of the Interim Pig and Poultry Holdings Act in 1984. In 1987 this Act was replaced with the prohibition of expansion and disposal of manure production. Since 1994, new conditions for the disposal of manure were specified as part of the Disposal of Manure Production Act. This provides a set of rules and regulations referred to as the System of Manure Production Rights. Thus in the early 1990s, the rules regulating manure production aimed to achieve a national balance between production and disposal possibilities of manure.

In the course of the 1990s, it became evident that stabilising the volume of manure production could not guarantee a national balance between production and disposal. Furthermore the tighter manure application standards, issued as a result of the application policies, made it even harder to achieve a balance as the amount of manure produced exceeded the amount of manure that could be applied. The poor integration between the manure application policies and the volume policies coupled with the need to comply with the EU Nitrate Directive meant that additional policy measures became necessary. According to Henkens and van Keulen (2001) it became increasingly clear that an effective manure policy required a system that took into account the large differences in manure surpluses, between different sectors and different regions.

In 1998 the Minerals Accounting System (MINAS) was introduced as a 'central instrument for restricting emissions of nutrients to the environment' (*ibid.*). MINAS implied a completely new approach to manure policy (Siemes 2001):

- The policy no longer focused on phosphate alone, but explicitly included nitrogen.
- The policy addressed nutrient surpluses, instead of manure surpluses, as the true problem and the measures were equally applied to chemical fertilisers, animal manure and other organic fertilisers, such as compost.
- The focus of policy shifted from specifying measures to setting targets to reduce the nutrient surplus, giving farmers (at least in theory) the freedom to decide which measures to use to reach this target.

The last change was only partially true as the restrictions on the permitted times⁶ and methods (e.g. obligatory slit injection of manure) remained in force alongside MINAS. Compliance with MINAS implies that all farmers are obliged to register the annual inputs of nutrients in livestock manure, organic manure, chemical fertiliser, roughage, concentrates and nitrogen fixation as well as the outputs of nutrients in agricultural products (milk, meat, crops, roughage) and in animal manure. These figures provide the basis for calculating nutrient losses per hectare (at the level of the individual farm). In order to comply with the EU Nitrate Directive, MINAS sets standards for losses (see Table 1). Farmers who exceed the maximum allowable loss standards have to pay a levy (see Table 2).

Table 1 Loss standards for phosphate and nitrogen in kg per ha per year (source: Siemes 2001)

Year	Phosphate loss standard		Nitrogen loss standard					
	arable land	grass-land	arable land	arable land (clay/peat)	arable land (sand)	grass-land	grassland (clay/peat)	grassland (sand)
2001	35	35	150	125	125	250	250	250
2002	30	25	150	100	110	220	190	220
2003>	20	20	100	60	100	180	140	180

Table 2 Levies on surpluses exceeding the loss standards in Euro per kg (source: Siemes 2001)

Surplus exceeding loss standard	2000/2001	2002	from 2003
<i>Phosphate</i>			
0 – 10 kg/ha	€ 2.30	€ 9.00	€ 9.00
> 10 kg/ha	€ 9.00	€ 9.00	€ 9.00
<i>Nitrogen</i>			
0 – 40 kg/ha	€ 0.70	€ 1.15	€ 2.30
> 40 kg/ha	€ 0.70	€ 2.30	€ 2.30

On the first of January 2002 an additional measure was introduced to ensure that the national production of animal manure did not exceed the quantity that could be applied on the total area of arable land and grassland. To achieve this, the government opted for an integral approach, based on the system of Manure Transfer Contracts for all livestock sectors (Henkens and van Keulen 2001; Siemes 2001). Farmers are obliged to enter into a manure contract and as part of this process must calculate how much nitrogen their farm produces. This calculation is based on the number of animals and a statutory fixed rate of nitrogen production per animal species. (These rates are laid out in the regulation that came into force on the first of January 2002). The farmer then needs to calculate how much manure can be deposited on his own land and how much he must sell to third parties. Some of the surplus manure might be applied on a neighbouring arable farmer's land, but contracts may also be signed with authorised manure processing plants. Farmers who are not able to dispose of their manure through any of these means will have to reduce their livestock numbers.

The combination of MINAS, manure application measures and the system of manure transfer contracts promised to be effective in terms of reducing nutrient and manure surpluses at both the farm and national level. Yet, these measures have resulted in a tremendous administrative burden for farmers and civil servants. In addition, a growing number of farmers are having difficulty with the combination of target-oriented policies (the MINAS loss standards) and means-oriented policies (the obligatory manure application measures). They have the opinion that the obligatory means are an obstacle to effectively meeting the MINAS goals. Despite difficulties in implementing the manure and nutrient policies, the Dutch government and the agricultural sector finally seemed to be on the right track for reducing the environmental impact of manure and fertilisers. However, in early October 2003 the European Court of Justice, in a case brought against the Netherlands by the European Commission, ruled that the Dutch system of rules and regulations (in particular MINAS) does not guarantee an adequate or timely realisation of the requirements of the EU Nitrate Directive.⁷

The development of VEL and VANLA in three trajectories

Introduction

This section focuses on the development of three trajectories⁸ that the environmental co-operatives have pursued since their beginning in 1992. The first trajectory involved the re-integration of environment, nature and landscape into the farming system (see Atsma *et al.* 2000). The second trajectory entails the emergence of the environmental co-operatives as

possible authorities for effectuating rural policies in their locale (Renting and van der Ploeg 2001). The third trajectory concerns the role that the environmental co-operatives have played as field laboratories, with a potential for re-orienting Dutch farming towards economic and environmental sustainability (Stuiver *et al.* 2003). These three trajectories represent an unfolding pathway of possibilities, frustrations, success and failures.

Integrating environment, nature and landscape into farming.

Nature and landscape

Besides the environmental legislation described above, the Dutch government also introduced several legal measures to counter the detrimental effects of ammonia deposition (acid rain) on ecologically valuable landscapes in the early 1990s. The governments' programme of nature development (known as the ecological guideline) declared that the hedges and belts of alder trees (so characteristic for the Friesian Woodlands) were sensitive to acid rain. This designation implied substantial restrictions on animal husbandry in the immediate surroundings and was seen by farmers as a threat to future development of their farms.

The members of the environmental co-operatives argued that in order to maintain the landscape, active management of these hedges and belts of alder trees was more important than acid deposition. The farmers were prepared to commit themselves to more active management of these features in exchange for a policy-decision that these features would not be designated as acid-sensitive. In practice this implied that the ecological guideline would not be applied to the area. After a period of negotiation involving local, provincial and national governments the deal proposed by the farmers was accepted in the mid nineties.

Since then, the environmental co-operatives have restored a total of 240 kilometres of alder belts and hedges – generally containing trees between 30 and 50 years old. Restoration involves pruning the trees and providing fences to protect the trees from cows. Ditches have been cleaned and new trees planted. Besides this, a new plan for landscape management has been drawn up for the whole area with a transparent formal structure for subsidies and regulation. This was drawn up by seven environmental co-operatives (including VEL and VANLA), which between them, cover the whole of the area of the Friesian Woodlands.

Environment

As discussed in the previous section, high ammonia emissions led to legislation that required manure application by the slit injection method. As a consequence farmers in the Friesian Woodlands were obliged to use specialised machinery required for this operation. However, farmers found that this machinery created problems, especially on lower-lying

land and in the open meadows. First of all they found it very difficult to work with these machines within small fields. Second, because of high water levels in spring, using the heavy machines had damaging effects on the structure of the soil. This meant that the farmers had to use more fertiliser to achieve the same results (which was bad for their nutrient balances). Soil compaction also had a serious effect on earthworm populations, which play an invaluable role in recycling (de Goede *et al.* 2003).

The farmers became concerned that farming in harmony with the landscape would no longer be possible, as the only viable way of using the machinery would be to enlarge the fields, thereby damaging the landscape. The farmers negotiated exemptions with the Ministry of Agriculture concerning methods of manure application. The result was that 20 farmers received permission for surface application of manure. Agreements that manure could be applied fourteen days later than the national norm of 15 September were also achieved.⁹ In return the farmers committed themselves to meeting the nitrogen loss standards (see Table 1) more quickly than the government required.

The farmers committed themselves to active participation in a number of different projects designed to reduce their nitrogen losses in a variety of ways:

- Since 1995 the members of the co-operatives have documented their MINAS results. This is an important tool for farmers to better understand the measures used to improve the nutrient management and to check the effectiveness of these measures. The farmers use the nutrient balances as an important tool to monitor whether the targets are reached.
- Some of the farmers use a manure additive called Euromanure.¹⁰ The farmers believe that this treatment reduces ammonia volatilisation and improves the condition of the soil. Farmers are convinced that surface application of manure is necessary in order to let this treated manure work properly.
- In order to overcome the problems with the heavy machines, the farmers have developed a lighter, 'area friendly' machine for manure applications. This machine is supposed to overcome the problems of soil compaction.

Integrated approach to regional solutions ('governance experiment')

In 1995 the Dutch Ministry of Agriculture started with a 'governance experiment' in which five environmental co-operatives (including VEL and VANLA) were given incentives to take responsibility for preserving nature, landscapes and environment within their areas:

'The request of the Ministry entails proposals for experiments concerning policymaking within the areas. The ministry considers our 'plan of action' as

a first 'governance experiment' that the Ministry wants to support. So our plan of action is an attempt to construct a new relation between governments and farmers, in which government give more space to farmers to solve their own problems within the farm and within the area. The environmental co-operative takes responsibility to solve these problems'. (Co-operative member quoted in Renting 1995)

The activities of the farmers within this governance experiment were intended to be as practical as possible, addressing the themes of nature, landscape, environment, as well as water management and recreation. Therefore close relations were maintained with the relevant authorities and organisations. Working groups were built around the different themes and all the stakeholders contributed to developing the action plan. (Renting 1995).

Through this governance experiment, (and also, as we saw, with the exemptions on manure application), the farmers of the environmental co-operatives, together with local, regional and national authorities, have been involved in building new institutional relations between the state and the farming population, based on new relations of trust. Farmers in the environmental co-operatives certainly question the heavy burden of state regulations that interfere with management at the farm level (Wiskerke *et al.* 2003). However they do accept and endorse the policy objectives set by state agencies. These new governance structures have enabled the farmers to generate substantial reforms and greater flexibility in their implementation. Legally conditioned forms of self-regulation (Glasbergen 2000) seemed to replace the centralised prescription of how policy goals are to be implemented at the local level. In this respect these governance experiments emerge as new institutional arenas for negotiation and co-operation on policy issues relevant to specific farming practices (Renting and van der Ploeg 2001).

However, the co-operation between the environmental co-operatives and the national governments remained problematic after 1995. The environmental co-operatives had the status of 'governance experiment', but this position did not give enough long term security for the future. For instance, the practice of surface application of manure had to be re-negotiated every year and approved by the ministries and parliament. In 1998 the Minister of Agriculture describes the conditions attached to continuation in one specific year:

'My plans concerning the 'governance experiment' are contained within this letter. [...]. Concerning the quality aspects for the maintenance of the alder trees I will ask the Province of Friesland to develop this as an experiment within the national programme of landscape maintenance. [...] The request to be able to apply manure after 15th of September can be given under specific conditions. I will support your experiment in reducing mineral losses. I ask you to make a research proposal for 1998 till 2000, together with the scientific

institutions of the Agricultural University of Wageningen and the research station on dairy farming. Your research on (manure) additives will be part of this research. Under these conditions surface application of manure can continue.' (van Aartsen 1998).

However, the evaluation of the governance experiment in 1999 put an end to the shift towards local governance. This was not due a failure of the environmental co-operatives to meet their part of the deal. On the contrary, various positive evaluations produced evidence of the feasibility of the approach (Anon. 1998; Hees 2000). And although the Minister of Agriculture assured the parliament that the governance experiment was to be continued, it was decided at the same time that the environmental co-operatives would not receive an official governance status.

The negotiations between the stakeholders took another direction when, in 1998, the VEL and VANLA nutrient management project was set up (see next section). Exemptions to the rules became permissible only as part of scientific research. The report of a visit to the Friesian Woodlands from the Ministry illustrates this point:

'Annemarie Burger'¹¹ is convinced that leaders in dealing with sustainability, like the VEL and VANLA environmental co-operatives should be protected. At the same time we know that it is difficult for governments to deviate from generic regulations. That is why this is formulated carefully in the policies concerning agricultural nature groups. The exemption from the obligation to slit injection of manure is only legitimate and defensible for scientific purposes' (Bargerbos 2001)

Laboratories in the field

The diverse manure and nutrient management practices of the farmers became 'bundled' in the 'nutrient management project' that started in 1998. In this project 60 farmers (farming approx. 2800 hectares of land) aimed to achieve a substantial reduction of their nutrient (in particular nitrogen) losses. The nutrient management project was established for three main reasons. First it aimed at improving the understanding about the inter-dependence between the different elements of farming systems, as we can see in the following;

'The environmental cow does not exist. In Wageningen we thought for a long time that we could solve our environmental problems by improving parts of the farming system, like the cow. Now we know better, we have to think more about improving systems' (Koopman 1998).

This quote reflects the influence of Egbert Lantinga, a key member of the project team on developing mixed farming systems at the Minderhoudhoeve in Swifterbant. This shift towards a farming systems approach marks an important shift within science and politics towards seeking insights into farming systems and farming systems development,

as opposed to focusing on individual component parts of these systems (Anon. 2000).

Second, the nutrient management project also aimed to open some of the 'black boxes' of agricultural sciences, such as manure and soil. The research agenda therefore can be seen as a reaction to the dominance of one particular mode of knowledge production. The modernisation model favoured certain types of knowledge, such as milk production per cow, while neglecting others, such as sustainability. The same model also favoured certain scientific methods, often based within research stations and without any 'lay' involvement.

Third, the nutrient management project differs from conventional research concerning the influence of 'lay' people. Knowledge production departs from the active involvement of farmers and their expertise within the project. Their knowledge influences the design and methodology of the project. Furthermore the project proceeds on the basis of hypotheses generated by farmers. One main reason behind this is that the scientists involved considered the practices of the farmers (as they have evolved over time) to be a sequence of novelties that merited further consideration and research. For the scientists the project became a field laboratory generating relevant research questions and delivering interesting new hypothesis (Stuiver *et al.* 2003).

The three trajectories of VEL and VANLA as different promises and associated practices (or novelties)

Figure 1 shows the simultaneous development of the practices and promises throughout the three trajectories of the environmental co-operatives. At the beginning, the practices of the farmers aimed to re-integrate dairy farming with nature, landscape and the environment (promise 1: integration of landscape). Simultaneously new options for the future were developed (like promise 2: increase nutrient efficiency). This second promise was the 'glue' of the nutrient management project that investigated the practices and associated novelties (see the next section). Finally this developed into the exploration of the possibilities for farming with fewer external inputs and the practices that need to be developed for this to be viable (promise 3: low external input farming). Others have called this simultaneous development of promises and practices the process of 'unfolding novelties' (Roep *et al.* 2003)

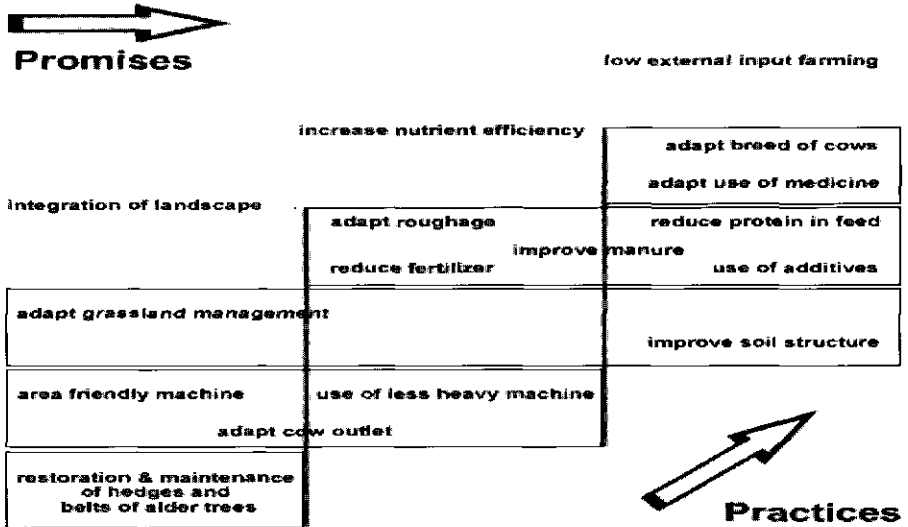
The VEL and VANLA nutrient management project

Introduction

The goal of the VEL and VANLA nutrient management project has been to find cost-effective solutions for environmental problems, through developing environmental practices that are appropriate to the local

context (i.e. the local farming systems, agro-ecological environment and social environment).

Figure 1 The simultaneous development of promises and practices



The project focuses on different aspects of the farming system (such as nutrient management) with a particular emphasis on decreasing fertiliser use, improving manure quality, adapting appropriate techniques for the application of manure and improving soil quality. The members of the project claim that the project has developed many innovations (or novelties) that have a potential for enhancing sustainability. In this chapter we present these novelties as the simultaneous co-evolution of three targets and associated practices (see Figure 1). This is illustrated by a quote from (one of the founding fathers of the project) Jan Douwe van der Ploeg;

'With the nutrient management project the VEL and VANLA environmental co-operatives aim to develop an innovative sustainable trajectory. First, the approach is specific for the region and embedded in the locality. Their farming systems are developed within and adapted to a unique landscape of small-scale parcels with hedges and belts of elder trees. Second, the approach is to increase co-operation among different stakeholders, farmers among themselves, farmers and scientists and farmers and politicians. Third, their approach is to gain more insight in the interaction between the different elements of the farming system (or the soil-plant-animal system) instead of optimising one element of the farming system' (Jan Douwe van der Ploeg in Verhoeven 2000).

In this section we analyse key elements of the nutrient management project and their relevance to the research activities that have taken place.

First, we describe the actors that were enrolled in the project, forming a social network that was needed to develop the research activities. Second, we describe the approaches to research that were performed within the project, which represented a departure from conventional approaches. Finally, we describe some examples of alignment practices designed to ensure that these promising novelties could mature and sustain themselves.

The creation of a social network for research

The nutrient management project involved 60 farmers with differing farming-styles, education levels, milk production levels and environmental achievements.¹² These farmers are in charge of the project. This is formally laid down in the organisational structure. Two project-leaders are responsible for day-to-day project management: an agronomist from Wageningen University and an employee of the farmers' union (the LTO). Various other scientists participate in the project including agronomists from The Research Institute for Animal Husbandry and Wageningen University, as well as soil scientists and social scientists from Wageningen University. Farmers' organisations and governmental bodies are also engaged in the project through funding.

At the beginning of the project, in 1998, a research council was established to design, govern and monitor the nutrient management project. The research council was composed of both farmers and scientists, representing those involved in the work of the project. Due to the prominent position of the farmers in the research council, the formulation and monitoring of the research process was farmer driven from the very beginning. The knowledge, experiences and insights of farmers were central to the development of the project. The farmers started with the project because they wanted to increase their knowledge about nutrient management. The ideas of the animal scientists visiting the area seemed attractive to them, as the next quote shows:

'We could not continue with farming within the prevailing policies of the government. The ideas of Jaap van Bruchem about the importance of the nutrient cycle within the farming system made a lot of sense to us at the time and we decided to work on the soil-plant animal system together with the researchers.' (Farmer during the VEL and VANLA evaluation 2003).

The scientists of Wageningen University that became involved in the project were searching for ways to develop knowledge that would contribute solutions for the environmental problems being encountered by agriculture. The social scientists already had extensive contacts with the farmers from previous work that they had done, identifying the challenges for the environmental co-operatives. This resulted in a plan of action (de Bruin and van der Ploeg 1990). The animal scientists were developing a farming systems approach in the Netherlands and found

striking similarities between the aim of their approach and the aims of the environmental co-operatives (van Bruchem *et al.* 2000):

'We have gone too far in intensifying our farming systems and this is having a negative effect on the soil, says van Bruchem. He proposes an introduction of the tropical approach where farmers return to more natural farming systems. [...] He is viewed with some suspicion in Wageningen but this year 2000 farmers have visited the Minderhoudhoeve research station where they experiment with his ideas' (Horst 1999).

Researchers of the Research Institute of Animal Husbandry (Praktijkonderzoek Veehouderij) were also involved. The Ministry of Agriculture made the participation of this Research Institute a prerequisite for financing the first phase of the nutrient management project, as the finances had to be taken from funds that had already been credited to the Research Institute. Regional representatives of the Ministry of Agriculture and the Regional Province were appointed to keep a close eye on this new initiative. The Farmers' Organisation NLTO was involved from the beginning. It provided one of the project leaders and in the second phase of the project it became the body responsible for spreading the novelties among farmers in the rest of the country.

The first phase of the nutrient management project ended in 2000. Promising results in terms of achieving environmental objectives (see Reijs *et al.*, this volume) and fruitful collaboration between farmers and researchers, encouraged the research council to apply for funding for a second phase. After a long period of negotiation between farmers, researchers and the Ministry of Agriculture, the environmental co-operatives got sufficient funding to implement an ambitious second phase of the project, which started in September 2001 and lasted till the end of 2003 (Verhoeven 2001). During this second phase more researchers with additional research activities became involved in the project, as we can see in the following table.

Table 3 Research activities of the VEL and VANLA nutrient management project (1998-2003)

<i>Research activities 1998-2003</i>	<i>Additional research activities 2000-2003</i>
<ul style="list-style-type: none"> • Data base on mineral management of 60 farms • Experiments with additives • Experiments with soil biology, grassland management and land use on 12 farms • Experimentation with manure practices, additives and grassland production on 2 on-farm plots 	<ul style="list-style-type: none"> • Social analysis on technico-institutional design • Monitoring farmers' learning processes • Monitoring relationships between fodder and manure quality on 8 farms • Measurements of nitrate levels • On-farm experiments with Ammonia emissions and manure quality • Monitoring Animal Health

Conducting research about nutrient management

'It is up to the scientists to translate our ways of farming into science and politics. We as farmers are convinced it works, because we see evidence in the results of the farm. Now scientists have to translate it into scientific results, but not in a reductionistic way as they are used to. They have to look at the farm as a system'.

Eshuis and Stuiver (2004) argue that 'agricultural research and extension systems have historically been focused on the issue of high yields and have neglected the issue of sustainability. This lack of knowledge about environmental friendly production has often been criticised. In a sense this ignorance has been created by this system' (Hobart 1993; van der Ploeg and van Dijk 1995). Furthermore they state that 'this knowledge, which claims to be universally valid, is always socially constructed within a specific locality, for example a laboratory or a test plot' (see Callon 1986; Knorr-Cetina 1981; Latour 1987). In their article they show that the nutrient management project endeavoured to meet the need of relating knowledge to specific socio-spatial environments, and in so doing generate sustainable solutions. The participants intentionally engaged in dialogue and co-operated with each other in order to create appropriate and applicable knowledge (see Chambers 1983; Clark and Murdoch 1997; Kloppenburg 1991). The nutrient management project aimed to reconnect conventional research under controlled circumstances with farming systems research and on-farm experimentation. This approach held different promises for all the participants: the farmers would benefit from the project through having practical tools and methods, the scientists with scientific outcomes and policymakers with regional specific solutions. In the following two sections different ways of doing research within the project are described.

On-farm experiments

The aim of the on-farm experiments was to modify natural science experiments to local circumstances. The form and scope of the experiments took different forms. One kind of experimentation focused on one component within the farming system (for instance the establishment of two research plots on manure, additives and grassland production). Another kind of experimentation concerned the development of the farming system as a whole (for instance the research on eight farms that monitored the relation between feeding strategies and manure quality). The on-farm experiments differ considerably from conventional scientific experiments. First, there was no random sample of farmers (only the members of the co-operatives participated). Second, one cannot speak of strictly controlled conditions (because every farm is different). Third, in practice there tended to be several independent variables at the same time (as alternative farming practices usually involve several variables simultaneously). This last factor was explicitly

recognised and used as strength, rather than that an attempt was made to minimise or standardise these differences.

It was not only the scientists who benefited from on-farm experimentation. The farmers learnt about the development of the soil-plant-animal system on their farm through on-farm experimentation:

'What a lot of farmers learnt was that by doing things in your own farm, you can solve environmental problems yourself. All the technical solutions were making us too dependent and costed us too much money. We wanted to take responsibility ourselves and find our autonomy instead.'

Lower protein and higher fibre diets were considered important in improving manure quality. The cows reacted to these dietary changes in different ways, and the farmers monitored these reactions and evaluated their effects. During this monitoring and evaluation the farmer adjusts the diet to what he believes (on the basis of his observations and interpretations) to be best for the cows. The adjustments are never ending: they continually lead to other adjustments. This process is a spiral, the farmers constantly adjust, monitor, evaluates and then adjusts again. Often the farmers discovered that they lacked knowledge, and have to deal with the changes on the basis of their available knowledge. In this way farmers learn by doing and do through learning (for a detailed discussion of this see Chapter 4 on farmers' knowledge, in this volume).

Exchange of information

The project provided several platforms where the data, hypotheses and outcomes could be discussed and compared by the (wider) network of involved actors. These platforms allowed farmers and scientists to get together and learn and exchange information about the ins and outs of nutrient management, soil-plant-animal system interactions and required socio-technologies and infrastructure.

A farmer explains how exchange of information made the project more interesting to the farming community:

'The social cohesion; increasing curiosity; farmers learning from farmers, these are all very interesting elements of the project. There is a lot of knowledge in Wageningen, but the farmers do not know what to do with it. But through encouraging farmers to learn together, the results become clearer for the farmers.'

Group meetings were an important way of enhancing the exchange of information. During these group meetings farmers' findings were discussed, compared and contrasted. A specific topic related to nutrient management was discussed, based on the experiences of the farmers (Eshuis and Stuijver 2004). Every farmer would recount his experiences on the topic at hand, thus sharing his knowledge on the subject. The project-leaders would facilitate the narration and discussion by asking questions, bringing in the experiences of other farmers they knew or drawing on

knowledge developed in scientific institutes (*ibid.*). Farmers saw a clear value in this process:

'I learn most from the stories of others. I prefer if people say that I do it wrong, then I can learn from that. I also expect the project to provide an analysis of the data, for instance why one farm has a better economic performance than another farm.'

It was possible to make farm comparisons as the project had invested in data collection and a central database. Both the farmers and scientists had, to a certain degree, free access to this database. The group meetings were used to help farmers and scientists discuss their interpretation of the results, overcome biases and to create mutual understanding. Visually aided forms of dialogue (videos, excursions, field visits) were used to stimulate these learning processes.

Another platform was the research council where the scientists, leaders of the environmental co-operatives, and regional ministries made crucial decisions for the development of the project. The researchers and farmers who participated in the research council advocated different ideas on relevant knowledge (or epistemologies). This meant that, the value of different categories of knowledge was continuously renegotiated at these meetings. One example of these negotiations between different epistemologies shows this process at work (see also Eshuis *et al.* 2001). Some of the farmers were experimenting with additives, such as Effective Microorganisms and Euromanure mixture in order to improve the farming system. These farmers strongly believe in the effects of these additives although their value is strongly contested by other farmers, scientists and government officials. These farmers claimed that the use of Euromanure mixture decreases ammonia volatilisation in the manure, improves its consistency and makes it easier to apply.

In 1996 the Research Institute of Animal Husbandry analysed the effects of manure treated with Euromanure mixture. They concluded that there was no difference in emissions between treated and non-treated manure. The farmers using the Euromanure mixture were sceptical about the findings of this experiment. They argued that the experiments had not been done in the context of a working farm and that the 'control' (untreated) manure that was used had a far lower N content than conventional manure (3.6 against 4.8 kg N/m³ manure). In the following quote the truth of the farmers is expressed:

'We cannot really prove that what we are doing is right. Many people think it only costs money. I can only say that there are changes that I see, which maybe cannot be put into official statistics, but they are relevant to me. We can however measure some of the outcomes; the farmers of the nutrient

management project who use Euromanure mixture have a higher C/N ratio in the manure’.

On the basis of their own observations of the manure and other relevant indicators, the farmers have drawn hypotheses upon which they can work. But until now these have not been ‘scientifically’ proven. This example can be interpreted as a struggle between farmers and scientists about what is true, or what data can be considered the truth. Epistemological differences about the issue of additives were not the only visible difference between scientists and farmers. There was also a struggle between competing groups of scientists on the research council – between those who strongly believe in on-farm research and a holistic approach as an engine of progress, and those who prefer a more reductionistic mode of investigation.

Eshuis and Stuiver (2004) argue that projects such as VEL and VANLA ‘have triggered a growing discussion amongst scientists and farmers about scientific research methods and the suitability of existing agricultural models and guidelines. The members of the nutrient management project have attempted to develop an alternative pathway to promote sustainable farming. But they do not always agree on the types of research needed to reach this aim. In the following section we will describe some of the alignment practices that occurred between the different actors and institutions.

Alignment practices

The novelties developed by the farmers and scientists need to be aligned with the techno-institutional environment in order to sustain and mature. Here we will present several cases illustrating how these alignment processes occurred.

Alignment among farmers to deal with sustainability

At the end of the 80s, at the start of the environmental co-operatives, farming was often perceived as separate from nature, landscape and the environment. As we mentioned in a previous section this separateness was not only part of people’s mindsets, but also embodied in the rules and regulations of the modernisation paradigm. Farmers’ organisations and individual farmers in the area were often not convinced that the novelties proposed by the environmental co-operatives were the right track to follow). As one of the initiators of the VEL recalls:

‘In 1990 farmers could apply for subsidies for nature conservation. None of the farmers’ organisations were interested. They said that they did not want farmers to become nature protectors. So we worked without them to apply for subsidies. We had a meeting in 1991 but still none of them wanted to co-operate. Then we said, all right, you are not obliged to participate but let us be part of the deal. This was before the start of the environmental co-operatives.

Later on when it became more interesting to apply for subsidies the farmers' organisations also wanted to join us.'

Since 1990 the integration of farming with nature, environment and landscape has become increasingly accepted among farmers and their organisations. In a previous section we discussed this in the broader context of the emerging rural development paradigm. Organisations like VEL and VANLA came to the fore in the debate, providing continuous news, excursions, meetings and lectures about their activities. As a result, more and more stakeholders (including farmers and farmers' organisations from all over the country) became curious. One result was that the farmers' organisations became willing to invest more time and money in the project and, in the second phase of the project they co-ordinated their activities for promoting awareness of the ideas of the nutrient management project nationally:

'We feel that the farmers' organisations acknowledge the value of our activities more. But we need to push this development further still. One way is to train farmers to train other farmers in our methods.'

New feeding strategies and alignment with the industries

The nutrient management project considered lower protein and high fibre diets to be important in improving manure quality. They believed that such a diet would result in a more efficient nutrient use by the cows and less protein losses through manure and urea. This meant that farmers needed to feed less additional protein to their cows, but as a consequence they needed to find other forms of concentrate to supplement the fodder. One farmer states:

'I use the ACM concentrate. I do so because it fits the criteria of the project.'

Many farmers in the project experienced a difference between the proposals being made by the project leaders and the advice they were used to receive from their suppliers, who used to advise high levels of protein intake. The interest shown by advisors in these novelties started to become influential in farmers' decisions about which suppliers to use:

'I am with ACM because the advisor believes in the system. I asked him and he said that he liked it.'

Furthermore, farmers needed to know what nutrients are inside the concentrates they buy in order to make their own decisions about the cows' rations. Often, however, this information was unavailable. It simply did not come with the order they received. This knowledge was not important when the farmers used high protein food but the change meant it became important again. The industries therefore had to develop both new products and better information for farmers. One farmer says:

'The fodder industries have realised that if they want to keep selling their products they have to listen to the needs of the farmers. They have learned from the project about the possibilities of reducing Nitrogen surpluses. We co-

operate well together at a local level and there are positive reactions from the national.'

Application of manure and government regulations

As we discussed in the second section of this chapter, the Dutch government imposed a package of technological innovations and legislation to overcome the environmental problems stemming from intensive agricultural production. These regulations were the same for every farmer. One example was the law on manure application technologies, which stipulated that manure should be applied by slit injection. As we demonstrated in the third section the farmers of VEL and VANLA thought of different ways to reach the environmental aims themselves. They wanted to use surface application of manure, because they were convinced that their manure does not smell, has lower ammonia levels and does not pollute the groundwater.

The farmers of VEL and VANLA were not the only farmers to experiment with other types of manure application. They were also not the only ones in the Netherlands who were convinced that surface application is better for the soil than slit injection. In 2002 and 2003 there were several court cases in the Netherlands dealing with this issue, in which the judge found farmers guilty of breaking the law but did not give them a fine, as this judgement illustrates:

'Loss of manure to ground water, does not occur at Theo Spruits farm. He knows that by looking at the high quality of water, which supports plant-life and fish. He considers slit injection of manure as damaging to the soil and unnecessary. In 1995 he was fined for surface application of manure. In 2002 he was convicted without punishment. He asked for an exemption to the rule but was not granted this' (van Zomeren 2003).

As we have seen in the previous sections, the farmers of VEL and VANLA were eventually permitted to experiment with surface manure application technologies but only in the context of the research project and after a lengthy period of negotiation with the government:

'You have to create space all the time to gain exemption from the rules, to claim space to achieve your goals. That game in The Hague appeared to be difficult. Some of the civil servants agree with us, but others do not agree or are afraid of the consequences.'

In May 2003 several scientists and representatives of civil organisations sent a letter to the Minister of Agriculture to explain that other ways of applying manure have to be made possible for these farmers to enhance their farming system.

'There is a total mixture of means and ends. Some farmers meet the ends, but do not agree with the means of the government. Give them space to meet the ends on their terms and do not punish them for meeting the ends. Of course

these farmers need to prove that their methods are sufficient' (WB 15 May 2003).¹³

A continuous process of political alignment was taking place during the project. Different groups of stakeholders were involved. The farmers and scientists within the nutrient management project who believe in the necessity of reaching a reduction of pollution with own means are faced with legislation that describes certain rules and regulations. In order to overcome these (in their eyes) restrictions, a lot of work is involved to protect the space that the farmers need in order to develop their farming systems in their own ways. This work is done not only by the farmers themselves but also by scientists and other agents like politicians who are sympathetic to the ideas of the farmers. The work is also done in different contexts like meetings in political arenas, during the research council and through discussions in newspapers (*ibid.*).

Synthesis: the characteristics of VEL and VANLA as a niche

Following the conceptual framework (Moors *et al.* this volume) and summarising the stories of this chapter, the VEL and VANLA environmental co-operatives clearly show the characteristics of a specific niche. In general terms, these include the following:

- New institutional relations between state agencies and the agricultural community;
- The re-embedding of farming in its local (social and ecological) context;
- New social networks of trust at local level;

New institutional relations between state agencies and the agricultural community

The VEL and VANLA environmental co-operatives represent an attempt to build new institutional relations between the state and the farming population. In so doing they endeavour to go beyond the generalised distrust that has permeated Dutch state-farm relations for some time. Environmental co-operatives certainly challenge the burden of state regulations that have been imposed on farmers and often intervene with farm management (Frouws 1997). While they generally accept and endorse the policy objectives set by state agencies, they question the rationality of centrally guided and prescribed policy-implementation and have asked for more (legal) space for self-regulation (Glasbergen 2000). In doing so they have constructed new institutional arenas for negotiation and co-operation on the policy issues relevant to their daily work and lives (Renting and van der Ploeg 2001).

The emerging institutional relations between the environmental co-operatives and the state are based on a number of principles of exchange. State agencies define clear and quantifiable policy goals with respect to

the environment (e.g. a maximum amount of mineral losses), landscape, nature, etc. for the area covered by the environmental co-operatives. The co-operative members promise to realise these goals effectively. In exchange the state grants more flexibility over the means of implementation. Farmers are allowed to develop and implement those measures and instruments that they consider to be most effective ways of realising the policy-goals within their own specific circumstances.

The re-embedding of farming in its local social and ecological context

The environmental co-operatives aim to give farmers the (institutional) room for manoeuvre to re-embed farming in its local cultural and ecological context. There are various ways of realigning farming, ecology and society, although the exact lines along which this can be done may vary significantly (de Bruin and van der Ploeg 1990). Yet, realising the potential to do this necessarily involves loosening the strong external pressures of highly prescriptive policy frameworks. In this respect, the environmental co-operatives are an attempt to restore the wholeness, contextuality and specificity of farming through reinforcing the craftsmanship of farmers and their capacity to produce tailor-made innovations that are fine-tuned to the particularities of localised settings (Roep *et al.* 2003; Eshuis *et al.* 2001).

Environmental co-operatives do not call for, or promote a simple deregulation of agricultural production; rather, they envisage a re-regulation of farming in line with the needs of their specific localities. Just as the modernisation model flourished because of the existence of a favourable institutional environment of policy incentives, research and extension, the renewed embedding of farming into the local area requires a responsive institutional back up (Wiskerke *et al.* 2003). Environmental co-operatives are pioneers experimenting with new codes and rules that might help to build new governance frameworks for regionally embedded farming systems. Nature management plans, nutrient balance systems, codes of conduct and farm certification schemes are some of the building blocks for these frameworks. Through such means the locus of control of farming and rural development is shifted back to local coordinators developing locally specific mechanisms and solutions. In other words, they contribute to the development of self-regulation as a new mode of rural governance (*ibid.*)

New social networks of trust at the local level

The environmental co-operatives are a means to overcome confrontations between stakeholders at different levels and develop trust between them. They promote the integrated development of land use and socio-economic activities in their region. By building bridges between different rural stakeholders (like suppliers of inputs and members of the tourist board and nature organisations) and different rural activities,

environmental co-operatives attempt to increase trust and to build new alliances (Renting *et al.* 1994). They consolidate and reinforce social networks that facilitate the co-operation of local actors. In doing so they create social capital (Putnam 1993) and, thus, the resource base for joint projects both in the present and the future. For instance, at the local level the governance experiment has had the effect of creating new social networks including farmers and other rural stakeholders. In doing so, it challenges the conventional perception of growing and inevitable conflicts of interests between farming, nature conservation, tourism and infra-structural development for living, industries and transport and offers a new way of reconciling conflicting interests over these issues.

Concluding remarks

This chapter illustrates the multi-actor, multi-level and multi-aspect characteristics of novelty creation. The focus of this chapter has been on the innovation journey of unfolding novelties within two environmental co-operatives and their confrontations with the patchwork of regimes within the Dutch dairy sector. We described the process that took place since '70's to control environmental problems within the dairy sector. New sustainability demands started to arise and affect the technological regimes that structured the dairy practices in the Netherlands until then. These changes involved the societal functions of the sector, the emergence of new actors and the subsequent changes of relations between actors in the regimes, and finally new technological approaches and regulations to come to grips with the environmental problems.

Furthermore we described the emergence of a niche starting with the rise of the environmental co-operatives. The environmental co-operatives were established with the aim to be a system of governance to implement the societal demands for sustainability. Around the co-operatives a network evolved. We have seen the formation and stabilisation of this network of actors that get involved in the identification and development of the novelties. There are different processes of learning and ways of doing research visible among these actors. We described the formation and stabilisation of strategies and expectations among the actors through the identification of novelties and the research to develop insights in these novelties.

The novelties that are researched and developed are an interconnected set of technological and farming systems innovations to downgrade the growth factors within the farming practice connected with the adjustment of other growth factors. Novelty creation involves several underlying processes: reflexivity in practices; making the practices discursive among the actors in the network; adjustment of expectations and strategies and; learning about the different practices.

We have analysed the internal and external dynamics of niche development. First of all the dynamics within the niche were reviewed: 1) the role of the different actors within the network: scientists, farmers and government officials, 2) the content and quality of learning processes and ways of doing research and 3) the process of alignment of expectations. Second the external dynamics of niche development were analysed: the hidden novelties are rediscovered and get meaning because of the changes within the regime. At the same time the niche provides a protected space to mature the novelties because the existing regimes conflict with these novelties.

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Notes

- 1 Recent crises such as swine fever, BSE and Foot and Mouth Disease have given an additional impetus to this shift.
- 2 The Friesian Woodlands cover 12.500 hectares of land. They are a combination of small-scale and enclosed landscapes on the higher sandy soils and relatively open areas on the lower peat-clay soils. The small-scale landscapes are formed by hedges and belts of alder trees surrounding the plots of land, resulting in a unique mosaic of fields. In agricultural terms the province of Friesland is characterised mostly by dairy and arable crop production. Arable agriculture takes place on the northern clay soils near the seashore and dairy production on clay, peat and sandy soils in the rest of the province (De Bruin 1997).
- 3 The VEL has 65 members who manage 1,600 hectares. The VANLA has 144 members who manage 3,550 hectares.
- 4 This is not only relevant for this chapter but also serves as a background for the next chapter of this volume.
- 5 This is due to the (more or less) stable phosphorus/ nitrogen ratio in animal manure.
- 6 There is a ban on application between 1 September and 1 February on grassland soils susceptible to nitrate leaching. Between 15 September and 1 February there is a ban on application on other grassland soils.
- 7 It was unclear at the time of writing what the implications of this rule will be for these policy measures and regulations.
- 8 We have purposely opted for the term trajectories as opposed to phases as the latter would imply that one stage followed another, whereas the three trajectories have co-existed for the last 10 years.
- 9 The farmers are convinced that the period available to apply manure, was too short to achieve an optimal spread of animal manure. Normally the farmers improve their grassland by sowing seeds and spreading manure in September. At present they are convinced that spreading manure after September results in excessive levels of nitrogen loss.
- 10 Euromanure mixture is added to manure twice a week, so that it can ripen the manure.
- 11 She was the Director of the Ministry of Agriculture at that time.
- 12 Sixty farmers participated in the project. They are divided in three groups of 20 farmers:
 1. 20 farmers who use the Euromanure mixture and are allowed to application of manure on the surface: 'the Euromanure group'.
 2. 20 farmers who spread the EM (Effective Micro-organisms) on the grassland: 'the EM-group'
 3. 20 farmers who do not use any additives: 'the Control-group'.
- 13 At the time of writing, this discussion is still continuing.

6 The Nutrient Management Project of the VEL and VANLA Environmental Co-operatives

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6.1 Introduction to the nutrient management project

This chapter describes the on-farm nutrient management project of the VEL and VANLA environmental co-operatives (see also Stuiver and Wiskerke, this volume). Figure 1 provides a schematic overview of the development of the project, which has its roots in a heterogeneous set of farming practices (A in Figure 1) that already existed in the area. Throughout the 80s and 90s, farmers in the area were subject to a newly emerging set of regulations (B in Figure 1). The effects of these were twofold: on the one hand several regulations were at odds with the practices employed on the small-scale farms in the area (sometimes prohibiting them outright); on the other hand farmers became increasingly interested in the particularities of their own ways of farming.

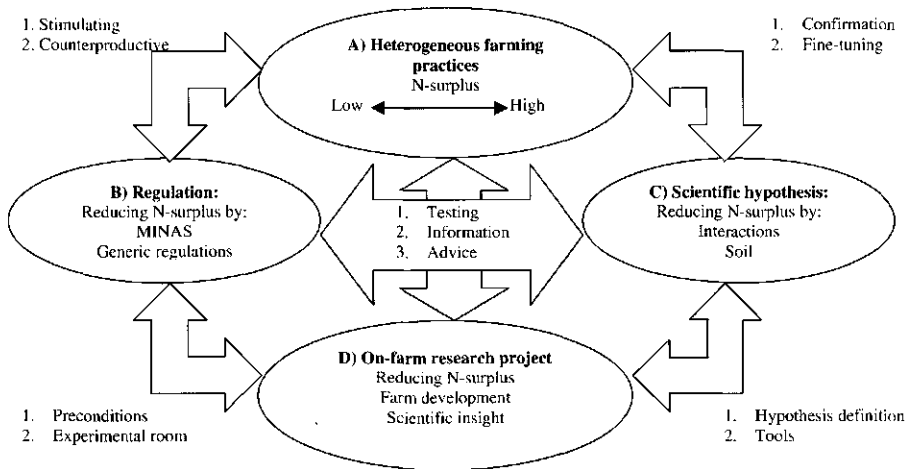


Figure 1 Schematic overview of the relation between farming practices, a scientific hypothesis, environmental regulation and the on-farm research project at the start of the nutrient management project of the VEL and VANLA environmental co-operatives.

An initial analysis of the nitrogen flows of 93 farms in the area showed a large variation in nitrogen surpluses between farms (see textbox 1). A number of farms appeared to combine very low N surpluses with high production levels. These farms showed a surprisingly high N efficiency: they became (if they were not already) interesting examples for other farmers in the area. This analysis, widely discussed by local farmers, was subsequently enriched with local insights concerning the most promising practices encountered within the area. According to farmers, differences in efficiency between farms were related to the presence (or absence) of what they referred to as a 'particular balance within the farm' (see Hoeksma's story in van der Ploeg 2003).

Textbox 1 A first analysis of nitrogen balances in the VEL and VANLA project

At the outset of the project (between May 1st 1995 and April 30th 1996) the nitrogen balances of 93 VEL and VANLA dairy farms were analysed (Verhoeven *et al.* 1998). The NEL content (net energy lactation, MJ.ha⁻¹) of the feed was computed (according to van Bruchem *et al.* 1999) in order to estimate the amount of N (kg.ha⁻¹) in the fodder produced on the farm. The NEL requirements of the herd, including dry cattle and young stock were subtracted from the amount of NEL in purchased feed. (These requirements were multiplied by a factor of 1.1, following observations in practice and in agreement with findings of Kebreab *et al.* 2003). For each farm calculations were made of the amount of N in the feed produced on the farm and of the NEL/N ratio met by on-farm production of fresh grass and grass silage. The N content of the manure was calculated as a function of the N produced in imported feed and feed produced on the farm minus the N in milk and meat.

The outcomes revealed a considerable diversity (see Table 1.1). Output of N on the farms ranged from 31 to 93 kg N ha⁻¹, with an average of 63 kg N ha⁻¹ (equivalent to approximately 11,500 kg milk ha⁻¹). Some farms already used relatively little inorganic fertiliser (154 kg N ha⁻¹) while others exceeded 400 kg ha⁻¹. The average dose was 292 kg N ha⁻¹. The amount of N imported in concentrates ranged from 31 to 197 kg N ha⁻¹, with an average of 97 kg N ha⁻¹. The (calculated) N surpluses ranged from 162 to 560 kg N ha⁻¹. This means that, in 1996, there were some farms that already met the 2003 target, whereas others would have to reduce their surplus by almost 400 kg ha⁻¹. The average N surplus on the participating farms was 326 kg N ha⁻¹, compared to an average surplus for farms in the Northern provinces of about 350 kg N ha⁻¹. The apparent N efficiency of animals ranged from 8 to 24 per cent, with an average of 17 per cent. The calculated apparent N efficiency of the soil ranged from 33 to 78 per cent with an average of 46 per cent. At farm level overall apparent N efficiencies ranged from 10 to 28 per cent with an average of 16 per cent.

Table 1.1 N flows and efficiencies in VEL and VANLA farms (n = 93) from 1 May 1995 to 30 April 1996

	<i>Minimum</i>	<i>Mean</i>	<i>Maximum</i>
<i>N flow (kg N ha⁻¹)</i>			
Products (milk and meat)	31	63	93
Concentrates	31	97	197
Fertilizer	154	292	478
Home-grown feed	182	280	434
Manure	195	314	533
Surplus	162	326	560
<i>Apparent N efficiency (%)</i>			
Animal level ^a	8	17	24
Soil level ^b	33	46	78
Farm level ^c	10	16	28

^a Calculated as product over concentrates plus home-grown feed; ^b Calculated as home-grown feed over fertiliser plus manure; ^c Calculated as product over fertiliser plus concentrates.

The differences between farms in apparent N efficiency and N flows started a considerable debate in the two co-operatives about the relationships between productivity and the use of inputs. Some of these relationships are shown in Table 1.2. It was discovered that the average dry matter yield per ha per farm was not related to the use of fertiliser and that the N surplus was not related to the amount of milk produced per cow. However, the amount of N produced per ha was strongly related to the amount of concentrates imported. The more intensive the farm, the more N was imported.

Table 1.2 Generic relationships derived from first regional appraisal.

$$\begin{aligned} \text{Dry Matter Yield (kg.ha}^{-1}\text{)} &= 7618 + 4.15 (1.91)' * \text{N fertilizer (kg.ha}^{-1}\text{)}; R^2 = 0.049 \\ \text{N surplus (kg.ha}^{-1}\text{)} &= 165 + 24.1 (7.87)'' * \text{Milk Yield (Mg.yr}^{-1}\text{)}; R^2 = 0.094 \\ \text{N product (kg.ha}^{-1}\text{)} &= 28.3 + 0.281 (0.026)''' * \text{N concentrates (kg.ha}^{-1}\text{)} \\ &\quad + 0.024 (0.012)' * \text{N fertilizer (kg.ha}^{-1}\text{)}; R^2 = \\ &\quad 0.632 \end{aligned}$$

Generic relationships were derived from (multiple) regression analyses. Standard error of the mean in parentheses. 'P < 0.05, ''P < 0.01, '''P < 0.001.

Although the term was not yet used, the promising practices of these farms were understood as 'novelties' (see introductory chapter of this book) that is, as practices that potentially contained solutions that could be applied to other situations. In this way a 'programmatic approach' emerged in which all the subsystems of the farm were considered potentially relevant in the search for sustainability. Subsequently, re-balancing became an increasingly central and self-evident notion: the

manure, the soils, the grassland management, the feeding strategies, the quality and composition of the milk could all be changed individually and be recombined in new ways that would result in more acceptable outcomes.

At that time, the scientists (C in Figure 1) who had performed the analysis (described in Textbox 1) had developed the hypothesis that optimising the 'animal' subsystem might prove counterproductive in reducing nitrogen surpluses, as this might induce negative effects at the system level (Van Bruchem *et al.* 1999). Rather, a combination of different elements of scientific knowledge with farmers' insights, led to the formulation and subsequently instigation of a programme with a more specific focus on sustainable and locally appropriate solutions. In contrast to the, then emerging, national agro-environmental policy, (which was technologically oriented) this programme focused on changes in management style. It was adapted to local conditions (e.g. the small-scale landscape) and oriented towards an overall re-balancing and downgrading, rather than a partial downgrading (see introductory chapter of this book).

The benefits of this approach were quite obvious. Scientists wanted to test their theoretical framework in practice and farmers felt the need to make their practices more explicit, more understandable and more defensible. The programme was, admittedly, a hybrid – especially in the beginning. Although reference could be made to specific scientific insights (as will be shown throughout this chapter), these were segmented, isolated, not tested on a broader scale and, as yet, not combined. The VEL and VANLA nutrient management project can be considered as a first attempt to a) systematically combine local and (new) scientific insights and b) put them into practice, monitor and, if needed, adapt them. An agreement with the Minister of Agriculture permitted the creation of a niche (or 'field laboratory': see Stuiver *et al* in this volume; and D in Figure 1) in which the programme could be set up.

In this chapter we will discuss both the theoretical background and practical outcomes of this research project. Section 6.2 provides a short introduction on the problem of nitrogen surpluses in Dutch dairy farming. Section 6.3 deals with some crucial theoretical elements that informed this research project. Section 6.4 describes the way these elements were moulded into the nutrient management project. Section 6.5 highlights the theoretical background of one important and characteristic element of the nutrient management project, the typical feeding strategy. Section 6.6 provides a summary of the technical results of the project and Section 6.7 concludes by examining the broader impact of the project.

6.2 Nitrogen surpluses in Dutch dairy farming

Dairy farming in Western Europe is mainly characterised by highly productive farming systems. High production levels are highly dependent on high external inputs of nutrients, mainly from fertiliser and concentrates (Oomen *et al.* 1998). These not only lead to high production but also to excessive emissions of nutrients to the environment. An analysis of the nutrient flows in Dutch agriculture revealed that dairy farming is the primary source of nitrogenous emissions, whereas the phosphorus surplus can primarily be attributed to pig and poultry production (van Bruchem and Tamminga 1997). According to van Keulen *et al.* (1996), nitrogen emissions from the milk and meat sectors rose from 36 to 83 million kilograms between 1950 and 1985. This was due to an increase in nitrogen inputs in concentrate from 8 to 153 million kilograms (almost a twenty fold increase) and in chemical fertiliser from 70 to 379 million kilograms, (more than a five-fold increase). Thus throughout this period the nitrogen use efficiency¹ (NUE) of Dutch dairy farming decreased by a factor of about 3, from approximately 45 per cent in the 1950's to only 15 per cent in the 1980s. From this data, we can calculate the marginal nitrogen use efficiencies to be around 20 per cent and 5 per cent for concentrates and fertiliser respectively. These low rates of efficiency are the cause of nutrient imbalances and the emission of excess nutrients from farms to ground and surface water and the atmosphere, all of which have adverse environmental impacts (see Jarvis *et al.* 1995).

From 1985 onwards the problem of nitrogen surpluses became recognised in both scientific and political circles and since this time the Dutch government has introduced a gradual tightening of policies to reduce nutrient surpluses (Oenema *et al.* 1998). Between 1986 and 1996, and probably as a consequence of these measures, the nitrogen surplus (inputs-outputs) of Dutch agricultural land decreased, but only by 14 per cent, from 618 to 535 million kilograms N (Oenema *et al.* 1998). In 1998, the government introduced the Mineral Accounting System (MINAS), an obligatory system under which farmers have to account for the inputs and outputs of nutrients and calculate the surpluses on an annual basis (see van den Brandt and Smit 1998, for a full description). The aim of the policy was to create enforceable and realistic measures that would comply with the EU Nitrate Directive (European Community 1991)².

From the late eighties onwards, much technical research, aimed at improving nitrogen efficiency in dairy farming has been carried out. Examples include the development of; low-emission housing systems (reviewed by Monteny 2001), manure application methods (van der Meer *et al.* 1987), feed protein evaluation systems (Tamminga *et al.* 1994) and improved recommendations for fertilisation (Oenema *et al.* 1992). This research has led to the development of new tools to reduce nitrogen surpluses in specific farming subsystems. At the same time possibilities

for reducing nitrogen surpluses at the level of the whole farming system also became the focus of study. One example is the prototype experimental farm 'De Marke' (Aarts 2000) whose work, from 1992 onwards, has shown that it is technically feasible to combine high production levels with low nitrogen surpluses, although with some increase in production costs.

By the late nineties, there were several examples of farms that had achieved low levels of nitrogen surpluses, while maintaining high production levels per hectare. The 'Cows and Opportunities' project, which involved 17 farms (Oenema *et al.* 2001) showed a variation in nitrogen surpluses of between 47-349 kg ha⁻¹ with an average of 207 kg (1997/1998 data). In the 'Farmers Data', project 91 dairy farms, scattered across the country succeeded in decreasing their nitrogen surplus from an average 237 kg ha⁻¹ in 1997 to 153 kg ha⁻¹ in 2002 (Doornewaard 2002). These projects show that the combination of high production levels and low nitrogen surpluses is not only technically feasible but can also be realised on commercial dairy farms. However, the average nitrogen surplus in the Netherlands remains high. In 1997, average nitrogen surpluses for specific groups of dairy farms in the Netherlands ranged from 220 to 440 kg N/ha, with an average of 308 kg N/ha⁻¹ (including animal correction: Reijneveld *et al.* 2000). The average MINAS nitrogen surplus of a sample of dairy farms³ in Friesland was 325 kg ha⁻¹ in 1997 (Anon. 1999). Increased pressure from the European Community, led the Dutch government to shorten the target period for reducing surpluses, from 2008 to 2003 (Henkens and van Keulen 2001). As a consequence, since 2003 farms have had to meet targets for nitrogen surpluses of 100 and 180 kg per hectare for arable land and grassland respectively. This implied the need for farmers to achieve an average reduction of approximately 150 kilograms nitrogen per hectare between 1997 and 2003, with some farmers having to reduce their surplus by as much as 300 kilograms of nitrogen per ha. Despite the efforts of the scientific community and of policy makers, the task of meeting these targets was (and remains) an enormous challenge and is compounded by the tendency of these approaches to increase costs (Aarts 2000). In the next section we focus on a number of crucial theoretical elements, surrounding the VEL and VANLA nutrient management project which, in our opinion, show the potential for meeting this challenge in a cost-effective way.

6.3 Crucial elements of the nutrient management project

Technology in society

The farmers in the VEL and VANLA area developed a proactive attitude towards the reduction of nutrient surpluses. In 1992, they were among the first farmers in the Netherlands to document the inputs and outputs of

nutrients on their farms (Anon 1994). However, these farmers found that several of the technologies being proposed (or imposed) as ways to improve nitrogen efficiency seemed inappropriate or counterproductive. Legislation requiring the injection of slurry into the soil was a prime example of this. The rationale behind this legislation was that injection reduces emissions of ammonia and increases the efficiency of use of N significantly in comparison with surface application (van der Meer *et al.* 1987). However, farmers in the VEL and VANLA region were concerned that injection of slurry into the soil would damage the topsoil and soil life and the heavy machinery would cause soil compaction, adversely affecting the sward quality and productive capacity of their permanent grasslands. Furthermore, the size of the machinery was inappropriate for the small fields in the area and, as injection was mostly done by contract-workers this would increase the costs of manure application, conflicting with the economical farming style of most farmers in the area, (van der Ploeg 2000). As a result, farmers considered injection of slurry as a threat to their production system rather than a tool to improve N efficiency.

This example illustrates that the success or acceptability of a single technology not only depends on its technical capacity but also on its effects on the entire production system, its environment and specific local conditions. A technology can never be isolated from its surrounding environment. Innovation, adoption and adaptation are all embedded in socio-technical regimes and overall socio-technical landscape. In this respect a promising technology or novelty (see introductory chapter) needs to be evaluated from a technology-in-society perspective (Rip and Kemp 1998). This perspective focuses on the interaction between technology and society and stresses the processes of co-evolution between technological innovations and social context.

System approach

The efficiency of nutrient use in Dutch agriculture significantly decreased from 1950 onwards, due to easy and cheap access to external inputs and management strategies based on the rationale of maximising short-term financial profits. The longer-term impacts of such strategies are indicated in Textbox 2. Relating these more generalised concerns to the level of the individual farm unit, requires the adoption of new integrative methodologies. (Waltner-Toews 1997). For example, flows of nutrients within a dairy farm, can be usefully understood by describing the farm as a single system, subdivided into four subsystems: soil, feed, animals and manure. This type of system approach is often used when seeking to reduce nitrogen surpluses at the farm level (e.g. Jarvis *et al.* 1995; Aarts 2000) and provides the basis for the current legislation (MINAS). A system approach makes it explicit that all subsystems are interrelated and changes in one part of the system affect the other components of the system. When production systems become unbalanced the efficiencies can

decrease, due to negative interactions between the subsystems. On the other hand, in more balanced situations, mutually beneficial effects can arise and the performance of the production system as a whole may surpass the total of the subsystems (Schiere and Grasman 1997). To optimise the outcomes of the whole system it is important to seek to improve the coherence, or positive interactions, among the subsystems, rather than aim to maximise the performance of the subsystems in isolation.

Textbox 2 Theoretical optimization of external input level

Increasing inputs of fertiliser and concentrates can increase the outputs of agroecosystems. Figure A (below) shows a typical dose-response curve for this relationship. Initially the response-line is concave and the relationship is one of increasing returns (I in Figure 1A below). However, at external input levels beyond 100, the output curves become convex, and enter the domain of decreasing returns (II) and, eventually, domain III – that of decreasing yields and/or increasing problems/costs. In domain I, nutrient losses to the environment (Figure B) appear to be negative, with the system responding positively to management measures. In domain II efficiency decreases and losses to the environment increase, while in domain III the nutrient losses become extremely high. This stage represents economic activities with ecologically damaging side-effects, which ultimately become economically unsustainable.

In terms of production efficiency the optimum level of external inputs is the point at which the production curve changes from concave to convex. This optimum level should be used as the target for developing efficient production systems in all subsystems. We argue that this point is also where the probability of higher order positive interactions between subsystems is highest, resulting in a system output that exceeds the level of the mono-factorial dose-response outputs.

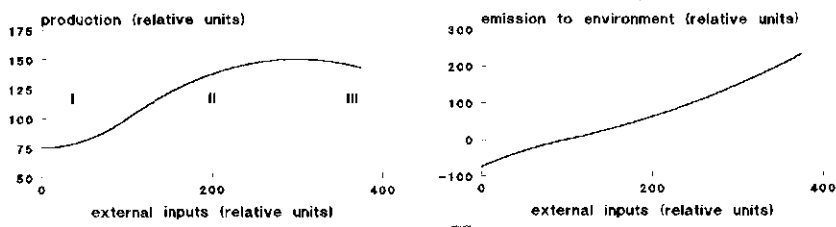


Figure 2.1. Output (production) and losses to the environment, relative to the external inputs: I, domain increasing returns; II, domain decreasing returns; III, domain decreasing yields (van Bruchem, unpublished).

The level of milk production per cow provides an instructive example of this principle. In terms of the individual cow a high level of milk production is more efficient, as proportionately less nutrients are required for its maintenance. However, if the roughage produced on the farm does not provide enough nutrients to reach this high production level, external

feed (e.g. concentrates) will be required. This implies a decrease of the production efficiency at the whole farm level, due to an imbalance (negative interaction) between the availability of roughage and the milk production level per cow.

Downgrading and re-balancing

The system approach provides one way to describe and understand a phenomenon that the VEL and VANLA farmers recognised as crucial, namely the creation of 'a particular balance within the farm'. Farming can also be described as 'the art of fine tuning'. Resources such as fields, cattle, crops, manure need to be unravelled and re-moulded in order to create combinations that are as productive and sustainable as possible and this unravelling and remoulding requires fine-tuning⁴ (Groen *et al.* 1993; Portela 1994; Bouma 1997; van der Ploeg 2003). With increasing insights (i.e. with developing local and/or scientific knowledge), and through adjusting individual growth factors (of whatever type), the whole is constantly being re-balanced. Hence, step-by-step improvements are created. Both these theories imply that a new optimal equilibrium in the dairy farming system requires a fundamental shift in management style from one of up-scaling and the management of single-factors, to downgrading and the implementation of multi-factor strategies.

Downgrading implies a reduction in the use of some growth factors in order to create a new balance that allows farming to be both ecologically and economically sustainable (see introductory chapter of this book). When this downgrading is well articulated it can result in an improved income, as a result of immediate savings (on fertiliser for example), but possibly also as a result of a range of indirect effects (for instance the improved health of the cows, reduced costs for animal replacement, etc). Generally, the process of re-balancing is slow, incremental and often barely perceptible, although careful empirical analysis can highlight its presence and potential (Swagemakers 2002). In periods of transition (such as the present time) re-balancing of farming systems as a whole comes to the fore. The reduction of nitrogen surpluses entails a reduction of external resources (mostly concentrates and fertiliser). This implies farmers becoming more dependent on their own specific resources (such as soil, roughage and manure) and needing to adapt their production system to their specific conditions. For instance, a reduction in the use of fertiliser will lead to a change in the quality of the pastures and the roughage produced. These changes in turn require an adaptation – or a re-balancing – of the type and amount of concentrates used, the optimal productivity and longevity of the cows, ideal breed of the cows, the type of grassland, and so on and so forth. Eventually, this downgrading will lead to an increase of heterogeneity amongst farms and farming practices.

This in turn implies that the need for farm and locally specific solutions will increase and that generic solutions will become less relevant.

Farmers' knowledge

A fourth important element of the nutrient management project was the direct contact between farmers and scientists and the use that was made of farmers' knowledge in the project. Farmers have years of experience and knowledge in organising and optimising their farms. This knowledge is not only based on scientific insights but farmer experimentation and experiences also play an important role (Stuiver *et al.* 2002). Often these two types of knowledge are expressed in different ways. To understand the underlying principles of improving nutrient efficiency, farmers and scientists had to explain their knowledge and experiences to each other. Farmers were encouraged to experiment with nutrient management on their farms and the results were discussed thoroughly with other farmers and scientists. These discussions were crucial: they contributed to the construction of shared hypotheses. Farmers and scientists enhanced their understanding about the data in the model and came to understand why nutrient flows varied between farms and how farmers influenced this by managing nutrient flows.

Besides increasing knowledge, these discussions generated enthusiasm amongst farmers and scientists and stimulated the farmers to actively implement new management strategies. The discussions also strengthened the confidence of the farmers in their own knowledge and decision making capabilities. Another consequence of the direct contact between farmers and scientists was to reduce the risk of misunderstanding between the two groups: differences in perceptions and language had to be overcome in direct discussion. During an evaluation of the project one of the farmers stressed the importance of these elements of the project:

'Social cohesion, curiosity, farmers teaching farmers, these all are very interesting elements of the project. There is a lot of knowledge at 'Wageningen' ⁵, but the farmers do not know what to do with it. But through encouraging farmers to learn together, the results become more clear for the farmers.'

This illustrates the importance of the direct interaction between the farmers and scientists involved in the project. The farmer describes the project as a joint learning process in which scientific and experiential knowledge were both crucial elements. In this respect the project can be seen as a field laboratory (Stuiver 2003). This farmer also stresses the practical benefits brought about by the increase of the availability and applicability of scientific knowledge created by the project.

6.4 The hypothesis of the VEL and VANLA project

Soil-plant-animal-manure

The farmers and scientists shared a common interest in finding out whether nitrogen surpluses could be reduced without causing a loss in production. Possibilities for increasing the nitrogen efficiency of mixed farming systems were already being investigated at the A.P. Minderhoudhoeve prototype experimental farm in Swifterbant (from now on called the APM) (Lantinga and van Laar 1997). To a certain extent this acted as an inspiration and starting point for the participants in the VEL and VANLA-project. This section discusses how the VEL and VANLA nutrient management project incorporated the different influences described in the previous section.

The analysis described in textbox 1 was presented to the farmers in the form of a 'soil-plant-animal-manure-picture' (see Figure 2). Later on, this uncomplicated and holistic picture became the 'trademark' of the project. Although it did not include all the available scientific knowledge about nitrogen flows at farm level, the picture summarised the nitrogen flows on a dairy farm in an accessible way and also introduced the notions of a system approach, the importance of efficiency and the interdependency of the different subsystems. Analysis of the successful strategies of local innovators was incorporated into this model in order to try to develop a novel strategy capable of further reducing nitrogen surpluses.

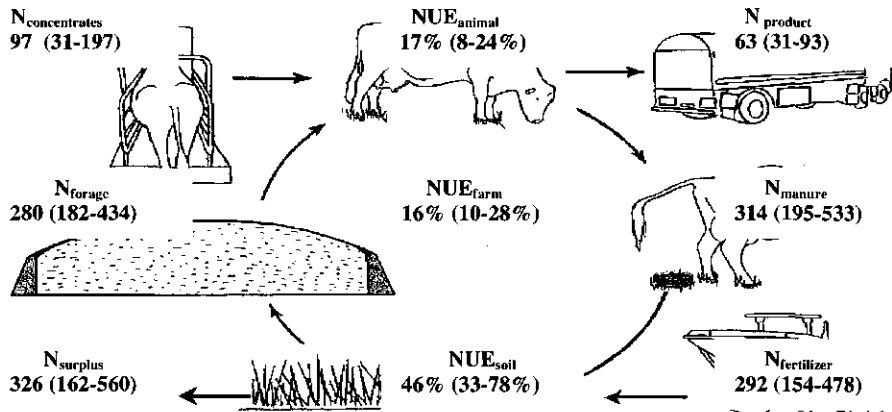


Figure 2 The characteristic soil-plant-animal-manure picture, showing average, minimum and maximum N flows ($\text{kg N ha}^{-1} \text{ year}^{-1}$) and efficiencies (%) of 93 farms in the VEL and VANLA area in 1995/1996.

At around the same time, Lantinga and Groot (1996) concluded that under integrated grazing and cutting management N losses per unit product are minimised at a rate of $200 \text{ kg mineral N ha}^{-1} \text{ yr}^{-1}$, leading to a reduction in production of only 10 per cent compared to grassland

fertilised with 400 kg mineral N ha⁻¹ yr⁻¹. Based on these and similar findings in Ireland and England, Lantinga stated in a popular magazine (Muller 1999) that the input of chemical fertiliser at farm level could be much lower than the current Dutch fertiliser recommendations without a significant loss in grassland production.

On this basis, a significant reduction in levels of fertiliser use was formulated as one of the main priorities in the project. It was concluded that the key to reducing nitrogen surpluses was to improve the N efficiency of the soil. A more efficient soil would need fewer inputs (manure and/or fertiliser) to produce the same output (roughage). To achieve this it would be necessary to improve the utilisation of nitrogen contained within the manure produced on the farms. This could then lead to a gradual decrease in the need for *external* fertiliser. As in other projects running at the same time (e.g. Aarts 2000), this became the main aim.

Cows have a low digestive efficiency for N (e.g. Castillo *et al.* 2000). Approximately 75-80 per cent of the nitrogen ingested by a dairy herd is secreted in faeces and urine. Most farms in the Netherlands do not separate faeces and urine, but produce slurry manure, which has a high inorganic nitrogen content, which is highly volatile and easily lost to the atmosphere. Reducing volatilisation increases the efficiency of use of the nitrogen contained in the slurry. There are different ways to approach this. One strategy involves employing technical solutions, such as low emission stables or soil injection of manure. Another involves preventing emission by decreasing the inorganic N content of the slurry. The VEL and VANLA project choose to explore the possibilities of this second strategy. They recognised such a strategy might reduce the need for expensive technical solutions such as roofing manure storage areas, installing low emission stables or injecting the slurry manure into the soil. However, as we noted earlier, a change in one part of the farming system also requires a re-balancing of the whole. A reduction in the inorganic N content of slurry manure (combined with a lower fertiliser use) implies that plant growth will become more dependent on organic N. This however is not directly available to the plant but has to be converted by soil micro-organisms. This led the VEL and VANLA project to seek to change soil management so as to improve conditions for soil micro-organisms, though avoiding the use of heavy machinery and experimenting with microbial additives. They adopted the C:N (carbon : nitrogen) ratio of the slurry manure (widely used in organic farming) as an indicator of its quality. Increasing the C:N ratio of the slurry implied a change in the cows' diets, reducing the amount of protein and increasing the fibrous content. In addition, straw was added to the slurry and some farmers used additives that they expected to further improve the C:N ratio.

It was also anticipated that a gradual decrease in the amount of fertiliser used would lead to a decrease in the N content of the roughage produced on the farms. Cutting the grass later in the season would complement this and increase the fibrous material within the roughage. The roughage would therefore play a key role in the transition to high fibre/low protein diets. These diets would, in turn, increase the C:N ratio, and decrease the inorganic N content of the manure. Together these changes made a coherent and complete hypothesis. The challenge for the farmers was to apply these measures gradually, in such a way as to maintain their production levels. If they succeeded the N efficiency of their farms could gradually be increased and nitrogen flows through the system could be reduced.

Data collection in the project

The VEL and VANLA project started in 1997 and involved 60 farmers. In the first years the project team consisted of only a few members. The most important job for the project team was to stimulate the farmers and guide them by a rapid exchange of results and insights (see Stuijver and Wiskerke in this volume). The main aim was not to collect data for scientific research but to improve results at the farm level. Therefore, it was not possible for the team to collect detailed and accurate data for every farm. Choices had to be made in data collection. The results of this monitoring/data collection and the conclusions that can be drawn from them are discussed later, in Section 6.6.

Despite this, continuous monitoring of data and knowledge exchange were important pillars of the project. The farmers were continually adjusting the component parts of their farms: their fields, their manure, their management, their feeding etc. in order to find a new ecological and economical optimum, one characterised by an undiminished level of production, considerably reduced nitrogen surpluses and, in the end, a higher income. The farmers worked together with the scientists and explored the possibilities for their specific situation, using the whole toolbox of available measures. This diversity of experience makes the project rich and complex but, from a conventional scientific (and reductionist) perspective, also controversial, as it is difficult to separate or quantify the effects of individual measures separately from the others.

6.5 A typical feeding strategy in the nutrient management project

Feeding strategies

One key element of the VEL and VANLA project was to develop a new feeding strategy. This section outlines some of the technical and theoretical issues involved in this.

Different objectives can be used to guide the formulation of diets for cows. For example, one can aim to maximise milk production (quantity and/or

composition), the health of the cows, or to reduce the amount (and cost) of purchased feed. Bearing these objectives in mind, farmers search for an optimal equilibrium that takes account of the specific conditions on their farms and their preferred farming style (van der Ploeg 2003).

Several researchers have discussed the importance of feeding strategy in the context of reducing nitrogen surpluses (Tamminga 1996; Castillo *et al.* 2000; Børsting *et al.* 2001). If a reduction of nitrogen surpluses is a priority, then diet formulation becomes more dependent on the resources within the farming system. This will have the combined effect of reducing the amount of nitrogen imported in purchased feed and improving nitrogen efficiency at animal level. Diets with protein values that just meet requirements can still maintain high production levels, while reducing levels of nitrogen intake. Under these conditions the nitrogen use efficiency of individual animals can be increased from around 20 per cent to around 35-40 per cent (Tamminga 1996). Theoretically, the N loss of a 600 kg cow, producing 25 kg milk d^{-1} (5.2 g N kg^{-1}) and fed on a well-balanced (in terms of energy and protein) diet could be as little as 170 g N d^{-1} . In this ideal situation the efficiency of use of dietary N is almost 45 per cent (van Vuuren and Meijs 1987). A very small proportion of N is lost to the skin and hair. The remainder is endogenous urinary N and metabolic faecal N excess related to maintenance and milk production processes (about 70 and 100 g N d^{-1} , respectively). Assuming a daily dry matter (DM) intake of about 20 kg $\text{cow}^{-1} \text{ d}^{-1}$, the N content of the diet can be calculated to be about 15 g $\text{kg}^{-1} \text{ DM}$. This is equivalent to a crude protein (CP) content of 95g $\text{kg}^{-1} \text{ DM}$. However, in practice this ideal situation can never be reached because in such a protein-poor diet the protein-nutritional value (DVE)⁶ content will be insufficient to produce enough milk protein. Feeding experiments at APM have revealed that, in practice, the efficiency of utilisation of dietary N can reach about 35 per cent at most with cows producing 8500 kg milk yr^{-1} (5.4 g N kg^{-1}). In this situation, the optimal N content of the diet was about 20g $\text{kg}^{-1} \text{ DM}$ or 125 g CP $\text{kg}^{-1} \text{ DM}$.

The strategy developed at APM and promoted in the VEL and VANLA project sought to go beyond merely reducing protein content (see Figure 3). Reduction of the surpluses at farm level is not only a matter of efficient use of nitrogen at animal level. As noted in previous sections, animal efficiency is not the most important step in the reduction of surpluses at farm level. Improving N efficiency at farm level involves increasing the use of internal farm resources, specifically the contained N in manure. The production of high quality manure should be no less important than the production of high quality milk. In terms of the system approach: the optimisation of the animal subsystem should be subordinate to the optimisation of the whole system. The main difference between 'regular' low protein diets and the diets fed at APM and promoted at the VEL and

VANLA farms was that the latter also aimed to increase the diets' fibre content. The underlying idea was to increase the organic matter content of the manure (and thereby increase its C:N ratio) by increasing the amount of indigestible matter in the diet (Tamminga *et al.* 1999).

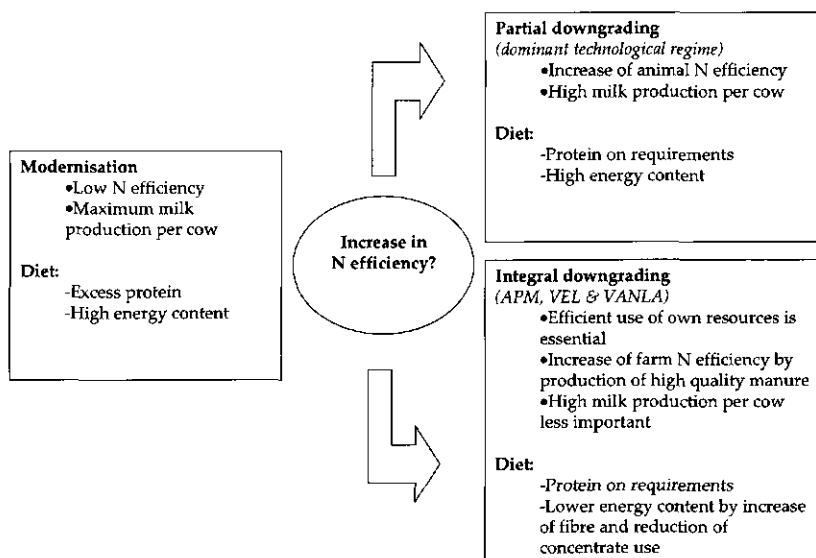


Figure 3 Schematic overview of the effects on diet type from two pathways of downgrading external N in dairy farming systems.

Effects of high fibre/low protein diets

High fibre diets can be expected to yield several positive effects. First of all, an increased amount of indigestible matter in the rumen decreases the risk of rumen acidosis by increasing the size of the fibre pool in the rumen and mechanical stimulation of the rumen wall (van Soest 1994). In the second place, sufficient indigestible matter stimulates rumination, which encourages more efficient use of nitrogen in the rumen due to the reflux of nitrogen via saliva and the rumen wall (van Soest 1994). Furthermore, the passage of more undigested organic material through the gut changes the fermentation pattern in the large intestine and leads to an increase of endogenous nitrogen. This nitrogen can be used for the production of microbial biomass in the large intestine (van Soest 1994; Tamminga *et al.* 1999) and leads to a shift in nitrogen excretion from urine to faeces.

Of course negative aspects of the high fibre/low protein diets can also be expected. First of all, less readily digestible diets do not provide the same amount of nutrients per kg dry matter as diets with high digestibility (Tamminga 1995). Thus the same amount of feed intake contains fewer

available nutrients, which has possible implications for milk production levels. Van Bruchem *et al.* (2000) compared two imaginary extreme diets and demonstrated that, in order to reach the same production level, the dry matter intake of a low energy/low protein diet would have to be 135 per cent of the intake of the high energy/high protein diet. Furthermore, one of the main limiting factors of feed intake, is the cell wall content of the feed, which is intrinsically high in high fibre diets. This implies that a high feed intake will be more difficult to achieve with these low energy/low protein diets. Therefore, to provide enough nutrients for a high milk production level, the intake capacity of low energy/low protein diets is of crucial importance. Tamminga and van Vuuren (1996) proposed the following formula for predicting feed intake:

$$\text{DMI (g d}^{-1}\text{)} = 6382 + 33.4 \text{ FPCM} + 11.3 \text{ LW} + 5.06 \text{ CONC} - 6.24 \text{ NDFR}$$

DMI = Dry Matter Intake

FPCM = Fat and Protein Corrected Milk ($\text{g kg}^{-0.75}$)

LW = Live weight of the cow (kg)

CONC = Proportion of concentrate dry matter (g kg^{-1})

NDFR = Neutral Detergent Fibre content of the roughage (g kg^{-1} DM)

This model has quite reliably predicted DMI for diets over a wide range of circumstances. However, experiments with total mixed rations conducted at the APM, which compared feed intake predictions based on this formula with the measured results, showed that this formula significantly underestimated the intake capacity of these diets. While the model predicted a DMI of 17.5 and 21.4 kg DM day⁻¹ for the late and early lactation stages respectively the real DMI was far higher, at 20.2 and 24.8 kg DM day⁻¹ respectively with milk productions of 24.2 and 36.3 kg day⁻¹ FPCM. This suggests that the production possibilities based on low energy/low protein diets may be higher than expected, due to an unexpectedly higher feed intake capacity. Therefore, stimulation of the DMI became another important issue within the VEL and VANLA project. Most important in this respect is improving the appeal of grass silages.

Whilst important, the volume of available nutrients is not the only limiting factor for milk production. The type of available nutrients also plays an important role. For milk production, nutrients can be subdivided into precursors for three groups of components; lactose (glucogenic nutrients), protein (aminogenic nutrients) and fat (ketogenic nutrients). Model-based predictions (Dijkstra *et al.* 1992) show that glucogenic nutrients are main limiting for milk production in the Netherlands. In relatively high protein diets the shortage of glucogenic nutrients can be replenished by glucogenic amino acids, while de-amination increases

urinary urea excretion. With low protein diets, fewer amino acids are available for glucogenic purposes and a shortfall of glucogenic nutrients could lead to a drop in milk production or milk protein content. Furthermore, high fibre diets stimulate the production of ketogenic nutrients (fat-precursors) leading to an increase of the fat content of the milk. Given the higher prices paid for protein (in comparison with fat) a high fat to protein ratio is not very attractive to Dutch dairy farmers. It is therefore extremely important to assemble a well-balanced diet that can provide enough (non-aminogenic) glucogenic precursors. Important factors in this respect are 1) sufficient rumen available energy to provide optimal microbial protein production and 2) sufficient availability of non-degradable starch as direct glucogenic precursors. In the longer term, breeding strategies based on the criterion of high milk protein content could also be developed.

Table 1 Development of average farm characteristics during the nutrient management project.

	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03
Number of farms	50	50	50	50	49	48
Area grass (ha)	42.7	43.9	45.1	46.1	46.6	49.5
Area silage maize (ha)	2.2	2.5	2.4	2.3	2.7	2.6
Total milk production (kg year ⁻¹)	522,910	534,169	559,772	573,238	592,628	599,825
Number of milking cows	67.7	69.4	70.5	73.3	77.3	78.7
Rate of young stock (10 milking cows ⁻¹)	8.2	8.2	7.7	7.6	7.2	7.4
Stocking Density (GVE ^A , ha ⁻¹)	2.0	1.9	1.9	1.9	2.0	1.8
Production intensity (kg milk ha ⁻¹)	116,62	11,534	115,33	11,651	11,844	11,449
Milk production (kg cow ⁻¹)	7,651	7,597	7,833	7,754	7,609	7,685
Fat content milk (%)	4.41	4.38	4.34	4.39	4.42	4.42
Protein content milk (%)	3.44	3.45	3.45	3.43	3.45	3.46

A GVE = Groot Vee Eenheid, stands for the total number of cattle converted to adult cattle units.

6.6 Technical results of the nutrient management project

Farm performance

Table 1 provides details of a number of key characteristics of the farms participating in the project⁷. The table shows that, in general the farms increased their total size during the project. This increase mostly involved increasing the available grassland area, while the percentage of the area used for silage maize remained stable. There was also an increase in total

milk production from 523 tonnes milk year⁻¹ in 1997/98 to 600 tonnes milk year⁻¹ in 2002/03. Production intensity and milk production per cow both remained relatively stable throughout the project. There was a slight decrease in stocking density, mainly due to a reduction of the number of young stock maintained on the farms. The fat and protein content of the milk produced remained stable.

Reduction of N surpluses

The main goal of the project was the reduction of N surpluses. Table 2 shows the changes in N balances of the participating farms. The average N surplus decreased from 299 kg ha⁻¹ in 1997/1998 to 156 kg ha⁻¹ in 2002/2003. By 2002/2003, 77 per cent of the VEL and VANLA farms met the thresholds set by legislation for 2003 (the following growing season). The efficiency of N use at the farm level has increased from an average 19 per cent in 1997/1998 to 31 per cent in 2002/2003. The decrease of the N surplus was mainly achieved through a reduction of fertiliser inputs, which fell from 270 kg N per ha in 1997/1998 to 126 kg N per ha in 2002/2003.

Table 2 Progress (mean \pm standard deviation) of the VEL and VANLA farms over the period 1997/98-2002/03 (n=50)

	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03
<i>N input (kg N ha⁻¹)</i>	369 \pm 77	336 \pm 84	284 \pm 76	244 \pm 72	240 \pm 70	227 \pm 57
Feed	97 \pm 30	101 \pm 30	93 \pm 28	89 \pm 25	102 \pm 31	99 \pm 31
Inorganic fertilizer	270 \pm 69	233 \pm 73	181 \pm 72	149 \pm 63	134 \pm 58	126 \pm 39
Organic manure	2 \pm 9	2 \pm 8	10 \pm 21	6 \pm 13	4 \pm 10	2 \pm 10
<i>N output (kg N ha⁻¹)</i>	70 \pm 19	72 \pm 14	70 \pm 16	69 \pm 13	71 \pm 12	71 \pm 14
Milk	57 \pm 12	59 \pm 10	59 \pm 11	59 \pm 10	60 \pm 12	59 \pm 11
Meat	10 \pm 4	11 \pm 4	10 \pm 3	10 \pm 4	11 \pm 4	12 \pm 6
Roughage	1 \pm 6	1 \pm 3	0 \pm 5	0 \pm 0	0 \pm 1	0 \pm 2
Organic manure	2 \pm 8	1 \pm 8	1 \pm 5	0 \pm 1	0 \pm 1	0 \pm 1
<i>Surplus (kg N ha⁻¹)</i>	299 \pm 82	264 \pm 84	214 \pm 69	175 \pm 65	169 \pm 62	156 \pm 48
<i>N efficiency at farm level (%)</i>	19 \pm 5%	21 \pm 6%	25 \pm 6%	28 \pm 6%	30 \pm 6%	31 \pm 6%
<i>Farms that meet legislation 2003 (%)</i>	8%	14%	31%	44%	63%	77%

However, the average N output (in milk and meat) did not change over this period, indicating that the farms were able to maintain their productivity. Over this six year period there was no increase in the input of feed-based N onto the farms, indicating that it was not necessary to compensate for the reduction of fertiliser N through extra feed N inputs.

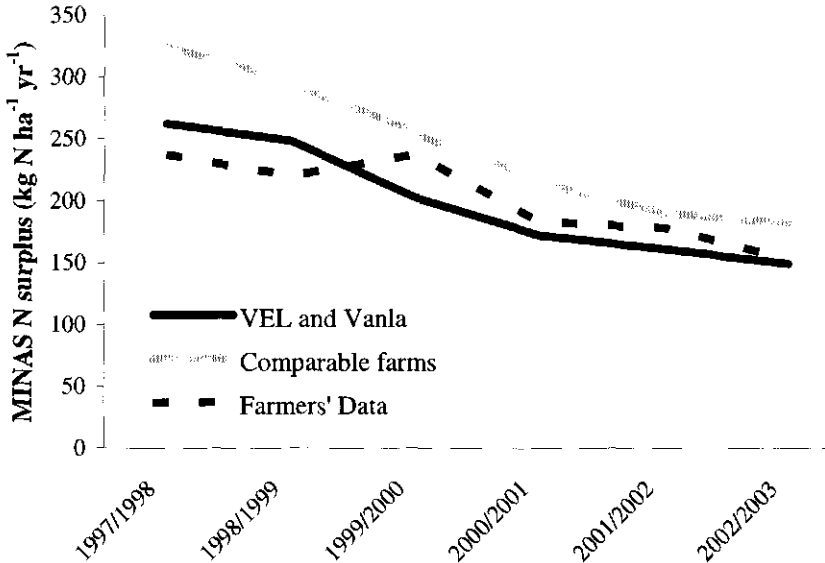


Figure 4 Progress of MINAS N surplus of the VEL and VANLA farms in comparison with the Farmers' Data project (Doornewaard 2002) and a reference group of local farms (Anon. 2003).

In Figure 4 the N surplus of the VEL and VANLA farms is compared with the results of the Farmers' Data project (Doornewaard 2002) and a reference group of dairy farms in Friesland (Anon. 2003). This graph shows that all three groups had considerable success in reduction of N surpluses although the surpluses remain higher on the farms of the reference group. It is worth noting that considerably more farmers from the VEL and VANLA project meet the 2003 target thresholds farms, compared to those from the Farmers' Data project (77 per cent and 56 per cent respectively). Moreover many farms in the VEL and VANLA project are going further and reducing their surplus below the legal thresholds. The reduction of N surplus in the VEL and VANLA project was also accompanied by a re-moulding of resources and the re-balancing of the soil-plant-animal-manure system. The main features of these changes are summarised below.

Changing grass silage as a part of the re-balancing strategy

Grass silage plays an important role in the soil-plant-animal-manure-system. On most dairy farms, grass or grass silage forms the major part of the cows' diet. In terms of system theory it constitutes the most important link between the soil and animal subsystems. One of the main aims of the project was to produce silage with a lower CP (crude protein) content (mainly as a result of the reduction of fertiliser use) and a higher CF (crude fibre) content (by cutting the grass at a more mature stage). In this way the silage would provide diets that were higher in fibre and lower in protein.

The chemical composition of grass silage depends on several other factors than the fertilisation level and maturity of the grass at cutting. Weather conditions play a particularly important role in determining these. To obtain an idea about their influence, the composition of silage produced on the VEL and VANLA farms between 1997 and 2001 was compared with the national average (Anon. 2002). The results (Table 3) show considerable annual fluctuations for both groups of farms and we assume that a large part of this variation is due to differences in weather conditions that applied equally to both groups.

Table 3 Grass silage characteristics (mean \pm standard deviation) of the VEL and VANLA (V&V) farms, in the 1997-2001 period, compared with national (BLGG) characteristics (Anon 2002)

Year	Source	n	DM (g kg ⁻¹)	CP (g kg dm ⁻¹)	CF (g kg dm ⁻¹)	Sugar (g kg dm ⁻¹)	DVE (g kgdm ⁻¹)	OEB (g kgdm ⁻¹)
1997	V&V	111	453 \pm 84	179 \pm 21	248 \pm 13	64 \pm 34	65 \pm 8	66 \pm 27
	BLGG		436	182	253	64	66	68
1998	V&V	146	432 \pm 95	166 \pm 22	250 \pm 21	72 \pm 35	68 \pm 12	48 \pm 22
	BLGG		415	174	252	60	70	58
1999	V&V	144	503 \pm 76	158 \pm 19	243 \pm 15	123 \pm 38	74 \pm 7	28 \pm 19
	BLGG		494	180	242	102	78	50
2000	V&V	112	460 \pm 82	167 \pm 19	258 \pm 15	75 \pm 39	72 \pm 7	44 \pm 24
	BLGG		480	176	256	74	76	51
2001	V&V	97	489 \pm 63	155 \pm 16	248 \pm 30	106 \pm 34	74 \pm 6	24 \pm 16
	BLGG		516	173	251	113	81	37

Over the longer term noticeable differences emerge between the two groups. In 1997 (the year before the project started) there was little difference in the CP and CF content of silage produced on farms participating in the project and the national average. During the course of the project, the VEL and VANLA farmers reduced the CP content of their silage. An important consequence of this reduction was the reduction of

OEB⁸, an indicator of possible surplus rumen N caused by feed stuffs. The reduction of CP content did not lead to a loss of the protein-nutritional value of the silages. The average DVE-content of the silages in the project even showed a slight increase, though this increase was smaller than at national level.

Regular contact with the farmers showed that, in general, they postponed cutting their grass. However, this did not, as anticipated, lead to an increase in the average CF content of silage produced by the VEL and VANLA farmers (at least in comparison with the national average). The figures do however, reveal a growth in the standard deviation of the CF content for VEL and VANLA farms in 2001, indicating that variation in the CF content is increasing. This suggests that, after four years of the project, a turning point has been reached in silage making, with different farmers adopting different strategies and achieving different results. In turn, this illustrates a growth in the heterogeneity of farms and their strategies.

Changes in diet composition in the project

From the second year of the project onwards (autumn 1999) the project also focused on changes in diet composition. From the first findings at the APM experimental farm, guidelines were formulated for diet composition on the VEL and VANLA farms. These guidelines can be summarised as follows:

- Limit CP (Crude Protein) to • 150 g.kg⁻¹ dm
- Limit OEB (degraded protein balance) to 0 g⁻¹ d
- DVE-values (true protein digested in the small intestine) must fulfil requirements for maintenance and milk production
- Limit VEM⁹ (net energy content) to ≤ 900 kg⁻¹ dm
- Limit the use of concentrates to ≤ 25 kg 100 kg⁻¹ FPCM.

Farmers were encouraged to work towards these guidelines. Diet composition and intake were recorded three times during the winter months (although no data were recorded in 2000/2001). Table 4 shows the changes in diet composition over the first years of the project. The guidelines and the first results were thoroughly discussed by small groups of farmers. In 1999/2000 a significant reduction of the average protein content (CP) was achieved and this was stabilised after two years. This reduction of the CP was mainly attributable to a reduction of OEB in the diet from 589 g day⁻¹ in 1998/99 to 277 g day⁻¹ in 2001/02 (Table 4). The farmers also succeeded in decreasing the use of concentrates from 30.6 kg (100 kg)⁻¹ FPCM in 1998/99 to 24.8 kg (100 kg)⁻¹ FPCM in 2001/02. Under these conditions milk production per cow in winter period increased, as did the fat and protein content of the milk. There was no reduction of the average net energy content (VEM) of the diets in winter

and the CF content remained unchanged. Overall these results suggest that the effects of the typical aspect of feeding strategy, i.e. the increase of the amount of indigestible matter in the diet have not (yet) been very pronounced. However, the increase in the fibre in diets has led to other subtle changes whose impact lies outside these dietary characteristics. Apart from changes in silage quality (discussed previously), there has been an increase in the use of small amounts of fibrous products such as nature conservation grade hay and straw which are used to complement diets that have a shortage on fibre.

Table 4 Winter diet and production characteristics (mean \pm standard deviation) of the VEL and VANLA farms: 1998/99-2001/02

Year	1998/1999	1999/2000	2001/2002
Number of farms (n)	46	46	46
<i>Average diet composition</i>			
VEM (kg ⁻¹ dm)	939 \pm 32	936 \pm 33	940 \pm 27
CP (g kg ⁻¹ dm)	167 \pm 15	157 \pm 13	157 \pm 12
OEB (g cow ⁻¹ day ⁻¹)	589 \pm 218	312 \pm 222	277 \pm 188
CF (g kg ⁻¹ dm)	198 \pm 17	201 \pm 13	203 \pm 18
<i>Concentrates use</i>			
(kg cow ⁻¹ day ⁻¹)	7.1 \pm 1.7	6.4 \pm 1.6	6.4 \pm 1.6
(kg 100 kg ⁻¹ FPCM)	30.6 \pm 6.7	27.4 \pm 5.6	24.8 \pm 5.1
<i>Roughage</i>			
VEM from own farm (%)	60.1 \pm 8.1	63.4 \pm 6.7	62.2 \pm 7.0
OEB (g kg ⁻¹ dm)	38 \pm 19	18 \pm 17	12 \pm 14
CP (g kg ⁻¹ dm)	157 \pm 21	144 \pm 18	140 \pm 16
CF (g kg ⁻¹ dm)	235 \pm 16	236 \pm 15	241 \pm 20
<i>Production</i>			
Milk (kg cow ⁻¹ day ⁻¹)	23.9 \pm 3.1	23.8 \pm 3.2	25.6 \pm 3.2
Fat content (%)	4.50 \pm 0.21	4.55 \pm 0.18	4.60 \pm 0.21
Protein content (%)	3.46 \pm 0.12	3.49 \pm 0.10	3.51 \pm 0.13
N-efficiency (%)	24.9 \pm 2.5	26.7 \pm 2.4	26.6 \pm 2.4

During the project farmers increased their knowledge about the relationship between the composition of diet and manure, milk production and the health of the cows. As a result they have become more

confident in decision-making and less dependent on advice from feed suppliers. Furthermore there has been a tremendous change in perception of the way diets should be composed. Objectives have shifted from high production levels towards manure quality, cow health and economic performance. This is illustrated by the following quotes from farmers in the project:

'In the past we wanted the manure of the cows to be as thin as possible. Then you had the maximum milk production. That is how we did it for years. But the quality of the manure those days was bad. It was an inevitable waste product. Now we try to combine optimal milk production with optimal manure quality. That is quite a different attitude...'

'...Now it is different, we have less sick cows. We feed more fibre, the rumen of the cow has to function properly. We don't ask for that maximum production anymore.... That is our choice.'

'I am not looking for that high production anymore. That is not what it is about. With the reduction of feed costs, we are increasing the economic performance'

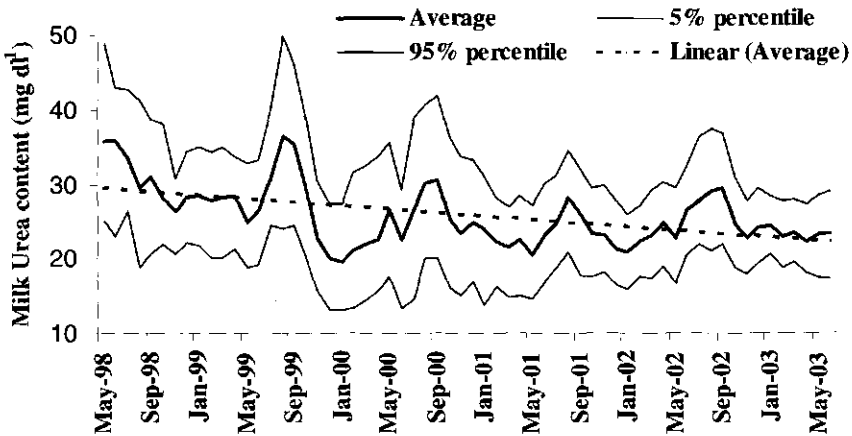
Milk Urea Nitrogen as a tool

Measurements of Milk Urea Nitrogen (MUN)¹⁰ provide a simple indicator that can be used to monitor N excretion from lactating dairy cows. It is used as a management tool to improve dairy herd nutrition (Jonker *et al.* 1998) and can help reduce excessive flows of nitrogen within the animal sub-system. Research carried out at the University of Pennsylvania has revealed that average MUN values for cows fed a well-balanced diet typically fall in the range of between 10-14 mg dl⁻¹ (Ferguson 2001). According to the Dutch Research Centre for Cattle Husbandry, optimum MUN for the total herd should be slightly higher, in the range of 11.5-14 mg dl⁻¹ (Anon. 1997)¹¹. These figures provide a safety margin to ensure that individual cows are not subject to a negative OEB. However, theoretically, OEB values might be zero if the DVE value of the diet is sufficient to meet the cow's dietary requirements. In fact, to ensure recycling of N in the rumen, OEB has to be negative. As MUN has been shown to have a positive relation with urinary N excretion (Jonker *et al.* 1998; Kauffman and St. Pierre 2001) many farmers in the nutrient management project adopted a target of low MUN values of between 9-10 mg dl⁻¹.

Since 1998 milk urea levels have been monitored in the Netherlands. Figure 5 shows the results of milk urea content of the farms participating in the project. The figure shows that milk urea content displays strong seasonal fluctuations, with high peaks during the grazing seasons. Over the course of the project this fluctuation decreased, indicating that the farmers improved their control over the milk urea content. This may be due to either better management or lower N-contents of the grass and

grass silages. The linear regression line in Figure 5 indicates an average reduction of milk urea content from 30 mg dl⁻¹ at the beginning of the project to 23 mg dl⁻¹ at the end (a reduction in terms of MUN from 14 to 11 mg dl⁻¹). According to a formula developed by Kauffman and St. Pierre (2001) this reduction in MUN would imply a reduction of urinary N excretion of 52 g cow⁻¹ day⁻¹. Given that 42 farms participated in this experiment, and, assuming an average herd size of 60 milking cows, this implies an annual overall reduction of almost 50 tonnes of urinary N excretion. While this is already a significant reduction, regular contacts with commercial farmers throughout the country and (unpublished) results of APM show that it is possible to achieve MU levels as low as 5 mg dl⁻¹ without affecting milk production level or animal health. This shows that there remains a large potential for further increasing nitrogen efficiency at animal level.

Figure 5 Changes in Milk Urea content (mg dl⁻¹) on VEL and VANLA farms (N=42) during the nutrient management project.



Changes in manure quality?

Several studies have shown that nutrition management can substantially contribute to a reduction in ammonia emissions (Smits *et al.* 1995; Külling *et al.* 2001). Phillips *et al.* (1999) reviewed different approaches for reducing ammonia emissions from livestock buildings and identified the best options as 1) dietary manipulation and 2) increasing the C:N ratio by generous use of bedding. These were the two main strategies adopted in the VEL and VANLA project, through which the farmers aimed simultaneously to increase the C:N ratio and to reduce the inorganic N content of their slurry manure. Both strategies aimed to reduce gaseous emissions. Table 5 shows the extent to which the farmers succeeded in these aims. The winter of 1999/2000 was the first period that the project

focused on feeding high fibre/low-protein diets. The average inorganic N content of the slurry decreased, while the percentage of organic N and the C:N ratio increased. Most striking is the change in inorganic N, which decreased by 28.6 per cent. These findings are in line with the decreased urinary N excretion suggested in the previous section. According to Erisman (2000) this reduction in inorganic N would imply a considerable reduction of ammonia volatilisation. A good impression of the underlying changes can be obtained from the percentage of farms that produce slurry manure containing less than 50 per cent inorganic N (Table 5, last column). In 1996, an average 54 per cent of N in Dutch slurry manure was in inorganic form (Mooij 1996). In 2002, 93 per cent of the VEL and VANLA farmers had levels below 50 per cent.

Table 5 Slurry manure characteristics (mean \pm standard deviation) of the VEL and VANLA-farms in the period 1998-2002 (one sample per farm per winter), in comparison with standard values (Mooij 1996).

	<i>n</i>	<i>DM</i> (g.kg ⁻¹)	<i>OM</i> ^a (g.kg ⁻¹ dm)	<i>Total N</i> (g.kg ⁻¹ dm)	<i>Inorganic N</i> (g.kg ⁻¹ dm)	% <i>Inorg. N</i>	<i>C:N</i> ^b	# Farms < 50% <i>Inorg. N</i>
1998	54	90 \pm 19	718 \pm 40	52 \pm 7	28 \pm 8	53 \pm 10	7.0 \pm 1.0	29%
1999	54	93 \pm 24	705 \pm 52	54 \pm 11	30 \pm 10	56 \pm 10	6.8 \pm 1.4	18%
2000	54	96 \pm 14	737 \pm 35	51 \pm 7	24 \pm 7	46 \pm 8	7.3 \pm 1.1	69%
2001	47	99 \pm 20	718 \pm 62	50 \pm 7	20 \pm 6	40 \pm 11	7.3 \pm 1.1	86%
2002	45	92 \pm 15	752 \pm 32	47 \pm 6	20 \pm 5	42 \pm 8	8.1 \pm 1.2	93%
<i>Mooij (1996)</i>	90		733	54	29	54	6.8	-

^a Organic Matter

^b The C:N-ratio is calculated as $(0.5 \cdot OM)/2$. The assumption is made that 50 per cent of the organic matter is C.

Besides reducing gaseous N emissions, changes in manure composition can be expected to induce other effects. When animal manure is used as a fertiliser it has two effects: 1) the short-term release of nutrients and 2) an increase in soil fertility status. These effects are, in turn, a function of the stability of the organic compounds in the manure, which can vary significantly between different manure types. Factors, which influence this include, the type of animal, the way the manure is stored and the composition of the diet. In general, the soluble inorganic fraction in urine is available almost immediately, the gastro-intestinal (endogenous) secretions and microbial matter excreted in the faeces are rapidly degradable and the undigested feed fraction is usually slowly degradable in soil (Velthof *et al.* 2000). Slurry produced under the feeding strategy adopted by the VEL and VANLA project is likely to contain less soluble inorganic (urinary) N and a more microbial matter, endogenous material

and undigested feed. It is anticipated that this will reduce the short-term release of N (Reijs *et al.* 2003) and should make a positive contribution to soil fertility in the longer term.

At the APM, the amount of total nitrogen in the top soil layer (0-30 cm) has increased by about 90 kg per ha per year between spring 1996, when the alternative feeding strategy and use of straw as a bedding material was adopted, and spring 2002 (unpublished results). This increase in total soil nitrogen should gradually lead to an increase in the soil nitrogen supply for plant uptake (Langmeier *et al.* 2002; Silgram and Chambers 2002). Furthermore the changed feeding strategy should also reduce the rate of herbage rejection by grazing cattle following slurry manure application and decrease the phytotoxicity of dairy farm slurries (Reijs *et al.* 2003).

6.6 Concluding remarks

The project started with a group of farmers and scientists who were convinced that nitrogen losses could be reduced without reductions in production levels or incomes. As described in the first three sections, this hypothesis was inspired by existing heterogeneity in practice, which was assumed to have the common characteristics of achieving a 'certain balance' on the farms. By combining local farming practices and specific scientific insights, a toolbox of measures was developed to reduce nitrogen losses by improving the balance between different farm subsystems. The proposed feeding strategy was relatively new to most of the farmers and some farmers were initially hesitant about this approach, which appeared to contradict their generally accepted frames of reference. However, during the project quite a few farmers became enthusiastic about this approach and started to experiment with 'the toolbox' on their farms.

In general, the main goals of the project have been achieved. In 2002/2003, 77 per cent of the farmers had achieved the target set by the government for the next growing season. Production levels per hectare were maintained and production per cow increased slightly. A first analysis of economic data from the farms in the project reveals that involvement in the projects substantially contributed to the profitability of the farms (van der Ploeg *et al.* 2003). Most of the farmers are convinced that the nutrient management project has had a positive effect on their income. This is illustrated by a quote from one of the VEL and VANLA farmers.

'Now we are in control of the nutrient cycle, we know that we have spoiled a lot of things for a long time, not only with respect to the nutrients but also financially'.

As expected, the reduction of external inputs and the adoption of the toolbox of measures caused a chain of reactions on the farms. A reduction

in fertiliser use was followed by a reduction in the protein content of the silage, changes in the diet composition, milk urea content, manure composition and so forth. In an interview one of the farmers phrased it like this:

'Less fertiliser use implies other feeding. A few years ago my silage and grass were dark. Now it has become lighter. This has got to do with the nitrogen utilisation, which was far too low, both in the animals and in the soil.'

After 4-5 years of experimenting, reducing inputs, and searching for the right solutions for their specific situation, several farms seem to have reached a new equilibrium. Others are still searching. This new equilibrium can vary quite a lot between farms. In general, farmers are becoming more dependent on their own specific resources and their own management strategies. This implies that the management and skills of the farmer and their knowledge about specific, locally available resources are becoming more important. Increasingly these farmers have to adapt generic solutions relevant to their own specific situation and resources. The VEL and VANLA farmers have followed a variety of strategies that achieved the challenge facing the Dutch dairy sector: that of reducing their nitrogen surpluses very rapidly.

In this respect, the VEL and VANLA project can be seen as an example of the potential and importance of the skills and resourcefulness of farmers in harnessing farm specific resources to meet the more stringent new thresholds for nitrogen surpluses. The specificity of circumstances such as, soil types, position and size of fields, intensity, farm-size, and the quality of roughage and manure, all demand the development of specific knowledge and solutions. Any increase in the heterogeneity of resource use will have implications on the way in which research for, and advice to, farmers is organised. This new situation requires a greater contextualisation of research and advice services.

The nutrient management project has been successful through 1) combining local and scientific insights into promising practices, 2) implementing these practices at farm level, 3) testing and adapting these practices at farm level and 4) propagating the successful practices. The project has had a large impact on the national, as well as the regional, level. Various forms of knowledge dissemination, including magazines, newsletters, a website, excursions, lectures, courses, conferences and debates in different public media, have spread awareness of the project throughout the country. The characteristic soil-plant-animal-manure-picture has been displayed at local and national meetings about the improvement of nutrient efficiency. Through such activities, the project has been one of the triggers of a growing discussion among scientists, experts and farmers on scientific research methods (Stuiver *et al.* 2003).

The project has always considered the balance of the production system to be crucial. This balance needs to be created by farmers, moulding their own resources so as to create a coherent whole. The use of multivariate analysis might help to understand some of the complex interactions within these newly emerging patterns (Verhoeven *et al.* 2003). However, the re-balanced practices that have emerged from these changing production systems, also raises new research questions that require 'mono-causal' technical research. For instance: to what extent can feeding strategy influence manure quality? What is the effect of the changed diets on different aspects of animal health? What is the effect of different manure quality, or composition, on grass yields? How to improve soil functioning? What is the effect of different manure types on soil functioning? What is the effect of the use of additives or straw in manure? The VEL and VANLA project cannot provide solid answers to all these questions. Further experiments, under more controlled circumstances, are needed to elucidate the changing mechanisms in this new, re-balanced, soil-plant-animal-manure-system that is running on far lower levels of external inputs than before.

However, answering these questions will not necessarily lead to the development of a sustainable and nutrient efficient dairy-farming sector. System innovation and transition in agriculture has to be based on the innovative work of farmers (Roep *et al.* 2003a). There are many farmers, throughout the Netherlands, making innovative experiments designed to improve nutrient efficiency (Roep *et al.* 2003b). These farmers have developed interesting novelties and often show surprisingly positive results. We argue that the contextualised knowledge that is already available and that has been produced on these farms is essential for any effective transition towards a really sustainable dairy farming. Therefore it is highly important that 1) scientific community comes into (or stays in) contact with these farmers to find solid answers to the complex questions of sustainability and 2) governmental organisations create sufficient 'room for manoeuvre' (Roep *et al.* 2003a) for innovative farmers to continue further development of their promising novelties.

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Notes

1 The calculations of NUE are apparent ones based on the N content of products divided by N inputs. Other inputs of N through biological fixation and atmospheric deposition are not taken into account, unless indicated otherwise.

2 This required a 50 per cent reduction of 1985 levels of nitrogen emissions from agriculture to surface water.

3 This sample covered Frisian farms larger than 45 hectares with an output of more than 12,500 kg ha⁻¹

4 The art of fine-tuning also involves the wide range of growth factors involved in agricultural production processes. Because of the mutual improvement of resources, as well as the mutual adjustment of relevant growth factors, specific, endogenous development trajectories and potentials are emerging and being sustained.

5 Wageningen University and Research Centre.

6 DVE stands for Darm Verteerbaar Eiwit or true protein digested in the small intestine, for a full description see (Tamminga *et al.* 1994)

7 The number of farms in the tables varies. This is a result of the inaccuracy of some data. Farms with inaccurate data in one year are not presented.

8 OEB stands for Onbestendig Eiwit Balans or degraded protein balance, for a full description see (Tamminga *et al.* 1994)

9 VEM stands for Voeder Eenheid Melk. Dutch standard for Net Energy lactation (1 VEM = 6.9 kJ)

10 Urea is formed from ammonia in the kidney and liver. Ammonia is produced by the breakdown of protein in the rumen and by the ruminant tissues and is very toxic, whereas urea is non-toxic. The conversion of ammonia to urea prevents ammonia toxicity. Urea diffuses readily from blood into milk. It is a normal constituent of milk and the measure of this can be used to estimate the concentration of blood urea. Urea concentrations in blood and in milk are influenced by protein intake, energy intake and urinary excretion.

11 In the Netherlands milk urea content is used instead of MUN. 1 mg MUN is equal to 2.14 mg urea.

7 A Co-Production Perspective on Soil Development in the Friesian Woodlands

Martijn P.W. Sonneveld, Johan Bouma and Tom Veldkamp

1 Introduction

Soil science has mainly developed along two distinct lines, both of which have their origins in the 19th century. One followed the work of Carl Sprengel and Justus von Liebig on the mineral nutrients of plants and the theory of the Law of the Minimum¹. The other one followed the work of Dokuchaev and Hans Jenny on the theory of soil forming factors. Soil classification and soil survey mainly originate from this second school of thought. Their products, soil taxonomic systems and soil maps respectively, have now been completed in many countries all over the world.

Humans have traditionally been regarded as being one of the soil forming factors. However, in general, soil taxonomic systems only include very major alterations to the soil profile caused by land use practices over a significant period. The effects of different types of management over shorter periods (of say, decades) are usually not considered². Thus, the man-made plaggen soils are for example recognised as separate classes but the effects of more recent changes in land use are not reflected within distinct (sub)-classes³.

The large amount of information that has been gathered about Dutch soils has provided the means to rationalise land use practices and increase agricultural productivity⁴. An influential textbook on theoretical soil science from 1970, written for employees of the Dutch Ministry of Agriculture, formulated productivity (P) as follows:

$$P = f[(S, C, L) M] \quad (1)$$

The symbols in this equation refer to aspects related to soil, climate, landscape and the management influences of the farmer respectively. Reasoning from the viewpoint of potential productivity (calculated for example on the basis of photosynthesis), the actual productivity of the land was thought to be a function of the limitations caused by these

production factors. This is expressed in the formula below, where the subscript l refers to limitations of these specific factors.

$$P_{act} = P_{pot} - [(S_l, C_l, L_l) M_l] \quad (2)$$

Soil suitability systems were developed which included qualitative assessments of the suitability of, and limitations on, agricultural land use, mainly based on expert judgment and field trials⁵. For example, for the Dutch grasslands, the soil suitability classification system included, factors such as moisture supply capacity, drainage status and trafficability, yielding a total of 28 possible suitability classes. These have been included in many subsequent soil survey reports. In suitability systems such as these, or other land evaluation systems, the effects of different land use trajectories within a single soil series or land unit are usually not accounted for⁶.

In recent years, concerns about the environmental impact of agricultural activities have stimulated the broadening of research aims. Such concerns can be seen as adding a further constraint on the potential production of a particular soil. Yet, they may also lead us to a different way of looking at soils. Recent publications have indicated that different agricultural practices carried out on, initially similar, soils can result in significantly different soil properties (Droogers and Bouma 1997; Pulleman *et al.* 2000). This insight provides a 'window of opportunity' (Bouma 1994) for re-balancing land-based agricultural systems, taking account the characteristics of specific soils within the context of the landscape and agricultural practices. In this approach, soils are seen as the result of co-production between natural processes with land use practices.

This chapter explores the potential of this co-production perspective for dairy farming systems in the Netherlands. It draws on empirical evidence from a case study, of the VEL and VANLA environmental co-operatives⁷ in the Northern Friesian Woodlands. The following section of this chapter provides a brief introduction to the characteristics of the region, and particularly of its soils. The soils in this area are sandy and the loss of nutrients, especially nitrate, to groundwater is an important issue. We follow this by a discussion of important land use trajectories for dairy farming in the Netherlands. The problem of nitrate leaching is discussed, together with the approaches that have been proposed to address this problem. In the light of this we review the different land use trajectories that have been adopted on a single soil series and show how they have led to different soil characteristics (specifically with respect to nitrate leaching) and thus lend themselves to different management strategies. In conclusion we discuss the issue of re-balancing co-production from a spatial point of view.

2 The Friesian Woodlands

2.1 Soil surveys

The soils of the Friesian woodlands have been extensively surveyed and mapped. Veenenbos (1949) undertook one of the earliest soil surveys of the Friesian Woodlands, a detailed soil and landscape survey which aimed at producing a map to indicate which soils were suitable as arable land, grassland and rotational land⁸. This survey later led to the publication of a landscape description and a soil map (Veenenbos 1954; Veenenbos 1964). Further survey work was carried out by van der Schans and Vleeshouwer (1956), whose work aimed at improving the hydrology of the VANLA area (in the municipality of Achtkarspelen). They also provided information on the suitability for grassland of the units that they mapped. Cnossen and Heijink (1958) subsequently made a more detailed description of the northern part of the Friesian Woodlands which, to a large extent, overlaps with the VEL and VANLA area. The Dutch soil classification system (de Bakker and Schelling 1966) initiated the mapping of soils across the entire Netherlands. The Friesian Woodlands were surveyed between 1972 and 1978, leading to the publication of 1:50,000 scale soil maps and additional reports (StiBoKa 1981). More detailed surveys of the area were performed by (Kiestra and Rutten 1986) and (Makken 1991), yielding additional information on soil properties and the distribution of soils in the landscape.

2.2 Landscape development

It is evident from these surveys that the current landscape of the Friesian Woodlands is to a large extent a man-made one, which has dramatically changed over the past one thousand years. Prior to these human interventions the landscape was shaped by Pleistocene (peri-)glacial morphology and Holocene peat deposits. The most southern part of the area belonged to the large till-plateau of the north of the Netherlands, where glacial till is covered by wind-blown sands. Large drainage valley systems were able to erode most of the till and cover sand in the northern part of the area. This provided the opportunity for marine influence when the sea level rose during the warmer climate of the Holocene. These wetter conditions stimulated peat growth, especially on the transition between the higher till-plateau and the lower lying marine areas. Peat also developed in poorly drained depressions in the sandy area and came to form substantial peat deposits in the northern provinces.

The earliest embankments were created before 1100 A.D. to protect the area from the sea. After the second half of the 13th century, dykes were created to more effectively protect the area against large-scale sea intrusions. This stimulated human occupation and reclamation of large parts of the peat area. Peat reclamation activities took place in different

phases but were mostly finished by the beginning of the 19th century. In time, large, mostly sandy, areas had become reclaimed for agriculture. Cultivation of arable crops was initially the most common land use on these sandy soils but in time most arable land was gradually transformed into grassland, and dairy farming has been the dominant land use for more than the past hundred years.

2.3 A typical soil

The typical sandy soils of the area closely resemble the renowned man-made plaggen soils⁹. The original sandy soils that developed in the Pleistocene covered sand deposits, had poor fertility and were also very wet. A mixed farming system was adopted where sheep manure was collected in pot-stables in which heather-sods were used as bedding material. The resulting plaggen manure, a combination of dung and heather-sods was applied to the arable fields. As well as increasing the fertility of the soil, this also gradually raised the soil, freeing it from frequent waterlogging¹⁰. These soils do not completely conform to the characteristics of typical plaggen soil and are sometimes referred to as plaggic intergrades (e.g. Pape 1970). In the former peat reclamation areas, the soil that appeared at the surface was also extremely low in fertility. As a consequence, it became common practice to mix peat remains with the underlying subsoil dredged from reclamation canals. These canals also provided the infrastructure to bring in large amount of city waste and materials from artificial hills, both of which improved fertility. Hence, a man-made surface layer was developed on these sandy soils, which, from a soil morphological point of view, makes them comparable to the plaggic intergrades. Many of these soils are classified as 'laarpodzol'¹¹ soils and belong to the cHn23 soil series. They cover large parts of the northern Friesian Woodlands and constitute more than 40 per cent of the land in the VEL and VANLA area. Most of the land in this soil series is currently used as grassland. These have been subject to different trajectories of land use, following recent developments and trends that have occurred in Dutch dairy farming.

3 Land Use Developments in Dutch Dairy Farming

3.1 Cultivation of silage maize

One of the most eye-catching developments in dairy farming in the Netherlands has been the increase in area used to cultivate silage maize (*Zea mays* L.). Before the 1970s the area used for maize was negligible, but by the 1990s it had grown to more than 200,000 ha (Table 1). In some exceptional years during the 1990s more than 230,000 ha of maize was grown.

Table 1 Area in The Netherlands used for growing silage maize (1000 ha, source: CBS 2000)

Year	1970	1975	1980	1990	2000
Netherlands	6.4	77.5	139.1	205.8	205.0

Recent years (2001 and 2002) have seen a stabilisation of this figure at just above 200,000 ha. Some 60-70% (more than 130,000 ha.) of this maize is used for dairy farming (van Dijk *et al.* 1995). Several reasons have contributed to the widespread adoption of maize. Firstly, this roughage crop is fairly easy to cultivate and gives a good yield, of consistent quality. Secondly, the control and removal of weeds is simple. Thirdly, cultivation demands little labour or attention and the crop can therefore be grown on fields distant from farm buildings and can be managed by a contract worker. Fourthly, subsidies are available for maize cultivation (Anonymous 1993; Maenhout 1984). Finally maize is tolerant of high applications of organic manure, which means that it fits well in intensive animal farming systems. The possibility of growing maize on remote fields has meant that it is often continuously grown, without rotation. During the mid-eighties there were indications that this practice was leading to a decline in yields. At the same time, concerns were expressed about the effects that this would have on soil structure¹². Research carried out in the mid-eighties Alblas (1990) estimated that about 50 per cent of the maize fields in the Netherlands had a slightly compacted subsoil and severe compaction of the subsoil had occurred on some 25 per cent. Although the Ministry of Agriculture later provided some guidelines for minimising negative impacts on the soil under a regime of continuous cultivation (van Dijk *et al.* 1995), considerable damage to soil structure still seems widespread.

3.2 Grassland renovation

Another important change that has occurred in land use within dairy farming systems is the ploughing and reseeded of grassland. This is done, mainly to improve the botanical composition of the sward. As grasslands mature they generally go through a less productive period, called the 'years of depression' or in Dutch the 'sukkelperiode.' One strategy to offset this problem is to adopt ley-arable systems. However, a more widely adopted strategy for grassland improvement is that of ploughing and reseeded. Scientific interpretations of the benefits and disadvantages of this practice differ¹³. This is illustrated by Hoogerkamp (1974), who describes how research and extension agencies in the UK and in Germany arrived at conflicting views over the issue of ploughing and reseeded grassland. Field trials on experimental plots in the UK in the first half of the 20th century showed that production levels were greatly

improved when grassland was ploughed and reseeded. As a consequence, British researchers and extension workers advocated young (and especially temporary) grassland. Experimental work by German grassland scientists led them to different conclusions. They found that although production levels are higher shortly after reseeding, they quickly fall below the levels of old grassland. In consequence German farmers were advised to maintain their old grassland and ploughing and reseeding was not promoted.

In 1992/1993, it was estimated that reseeding was carried out on 4.6 per cent of the total grassland area in the Netherlands. This is lower than the figures for the 1980s (Verstraten 1996) but there are considerable regional variations. In the southern part of the Netherlands the figure is much higher, at 10 per cent. In 1999 the national figure had risen to 7.7 per cent of the total grassland area. In all some 70,000 ha, was being reseeded annually (CBS 2000). Eighty five per cent of this area was grassland that had been established for less than 15 years. This seems to indicate that the occurrence of the 'years of depression' acts as a major stimulus for grassland renovation.

3.3 *Maintaining old grassland*

Hoogerkamp (1984) drew on earlier work by 't Hart (1950) which suggested that the period of lower production can be overcome through proper grassland management and relatively good soil conditions which are the keys for creating high-quality old grassland¹⁴. The traditional farming phrase '*oude kracht*' (old force) is used to indicate this quality and is often used as a justification for not ploughing up old grassland. The high value attributed to old grasslands may be related to their generally high organic matter content. Some regard this as '*locked-up capital, bearing no current interest*' which can only be used when a conversion to arable land takes place (Davies 1960; cited by Hoogerkamp 1984). Hoogerkamp (1974) takes issue with this and emphasises the importance of organic matter for grassland production because it provides a more abundant supply of nitrogen. He also stresses that reseeding is costly and carries a considerable risk of failure. Other reasons also underlie the maintenance of old pastures. Tradition and the preservation of biodiversity¹⁵ are now frequently mentioned as reasons, but location, accessibility and the importance of the whole-farm strategy can also be important reasons for farmers (Janssens *et al.* 2002). In the VEL and VANLA area, farmers also mention that ploughing and reseeding brings less fertile subsoil to the surface in some parts of the fields (van der Ploeg 1999).

4 Soil as an Intermediary between Dairy Farming and the Environment

4.1 The problem of Nitrate leaching

After the 1970s it became clear that dairy farming was a significant contributor to the contamination of ground and surface waters by nitrate (Cameron and Wild 1984; Garwood and Ryden 1986; Ryden *et al.* 1984). Nitrate itself is not toxic but the process of reduction of nitrate to nitrite may lead to methaemoglobinaemia¹⁶, posing health problems especially for young children. According to the European Drinking Water Directive, nitrate concentrations in water are not allowed to exceed the maximum admissible concentration of 50 mg nitrate l⁻¹ (EC 1980). This same value was also used in the Nitrates Directive, adopted by the European Commission in 1991 (EC 1991). This Directive aimed to protect water against nitrate pollution from agriculture¹⁷. Its objectives were to control nitrate concentrations and to reduce the associated problems of eutrophication (Tunney 1992).

The leaching of nitrate from dairy farming systems may be the result of different processes¹⁸. In dairy farming, some studies indicate that grazed swards are particularly likely to lead to high nitrate concentrations (e.g. Scholefield *et al.* 1993; Whitehead 1995). Other studies have pointed to the leaching of nitrate following the ploughing of grassland (e.g. Lloyd 1992; Whitehead *et al.* 1990). This increase is mainly short term on reseeded pastures but may be substantial when a long-term arable period follows a grassland period. Losses of about 4 t N/ha have been reported from the upper 25 cm. Whitmore *et al.* (1992) found that in many areas in the UK, conversion of grassland to arable land may be held responsible for half of the nitrate concentrations observed in groundwater.

Recently established, ageing swards, there is generally a built-up of organic carbon and organic nitrogen. Initial rates of nitrogen storage or immobilisation are often high (in the range of 50-150 kg/ha) but these will decline over time as the build-up is asymptotic. Scholefield *et al.* (1993) compared nitrate leaching from a ploughed and reseeded pasture and a nearby 40-year old pasture. Using a constant input level of 400 kg fertiliser-N/ha they found that nitrate leaching on the old pasture was consistently higher, but noted that substantial N loss had probably occurred on the reseeded pasture in the first winter after ploughing. Cuttle and Scholefield (1995) attributed this to the higher potential of reseeded grassland to immobilise nitrogen. Because the net accumulation of nitrogen declines as the pasture ages, they concluded that a constant nitrogen input will result in increased nitrogen losses over time. In younger swards the efficiency of N fertiliser is relatively low (in terms of grassland production) as a higher proportion of the nitrogen that is applied contributes to the build-up of organic matter in the soil, rather than contributing to grass production. On this basis the accumulation of

organic N in the soil will lead to increased mineralisation of soil-N and is an essential prerequisite to the greater efficiency of fertiliser use in longer established swards.

4.2 Addressing nitrate leaching at national level

Following the Nitrates Directive, the Dutch government implemented specific legislation to reduce nutrient losses from agriculture. In 1998, the Mineral Accounting System (MINAS) was adopted (van den Brandt and Smit 1998). This is a farm-level nutrient budgeting tool, aimed at achieving a reduction of nutrient losses, including nitrates, to the environment, and imposes levies on farmers who do not meet specified targets (Neeteson 2000).

This strategy involved developing thresholds that were both environmentally and agriculturally acceptable. Calculations of the agricultural acceptability were based on a series of (six) combinations of soil type and drainage status. These, it was assumed, would account for soil heterogeneity¹⁹. Other soil properties such as organic matter content, moisture and nitrogen supply capacities, were regarded as constants (van Eck 1995)²⁰. As discussed in the first section, the approach adopted in this desk-top study took existing soil suitability systems and superimposed environmental quality, (in this case the maximum admissible nitrate concentration in groundwater) as an additional constraining factor. Influences of soil management were not taken into account. When implemented the thresholds were simplified to two different soil types, with one loss standard being applied to dry sandy soils and the other to all other soils.²¹ Aside from imposing these thresholds, other regulations were adopted concerning grassland management and the use of animal manures and fertilisers (LNV 2001)²².

4.3 Local land use trajectories in the Friesian Woodlands

Sonneveld *et al.* (2002) have recently investigated the effects of different land use trajectories on the properties of soils in the cHn23 soil series that are currently under grassland. Some of the findings of this study are given in Table 2.

Table 2 shows that the upper layer of land previously under continuous maize cultivation has considerable lower amounts of organic carbon in comparison to both reseeded and old grassland and considerably less organic nitrogen compared to old grassland. The subsoil (25-50 cm) of land previously under continuous maize cultivation also has considerably less organic carbon. In total there is a difference of up to 58 tons C ha⁻¹ between (previous) arable land and old grassland. The differences in the subsoil are less pronounced which, to a large extent, is due to the higher densities of the subsoil. Differences between the bulk density of the sub soil and the topsoil were considerably lower for the old grassland (1.5 per cent) than on reseeded grassland and previous arable land, where these

values were 5.9 per cent and 4.1 per cent respectively. The bulk density of the subsoil of the maize field was more than 16 per cent higher than that of old grassland, a difference that could be expected to limit rooting possibilities.

Table 2 Variations in the properties of cHn23 soils according to differences in land use history

Land Use History	0-25 cm		25-50 cm	
	Organic Carbon	Organic Nitrogen	Organic Carbon	Organic Nitrogen
	tons ha ⁻¹		tons ha ⁻¹	
Grassland with previous cultivation of silage maize	89.2	9.3	90.5	9.6
Reseeded Grassland	119.3	9.5	102.2	8.6
Old Grassland	131.0	11.1	106.3	7.9

In general the survey showed that the ploughing of grassland to a depth of 25 cm leads to decreases of about 20 tons ha⁻¹ of soil organic matter content and 1.5 tons ha⁻¹ of organic nitrogen, in comparison with old grassland. This nitrogen will be partly taken up by the plant and partly lost to the environment. Averaging across the samples, we calculated that 67 per cent of the total variation in the percentage of soil organic carbon and 57 per cent of the variation in nitrogen content could be explained by land use history²³.

These findings challenge some of the assumptions that underpin soil suitability classifications, land evaluation systems and the recent classification systems that aim to achieve environmental goals. They show that agricultural practices have a significant effect on the characteristics of soils within this anthropogenic soil type. This influences the loss of nutrients to the environment and the risk of agrochemicals leaching into the groundwater (e.g. Droogers and Bouma 1997). In other words, locally different land use trajectories influence the relationships between agricultural systems and the (biophysical) environment. Dairy farms located on the same soil series, using similar fertilisation strategies may experience a wide range of economic and environmental outcomes because of spatially explicit variations in land use history. This observation provides an insight of potential value in the search for sustainable agricultural systems.

5 Spatially explicit paths towards sustainability

5.1 Local soil knowledge

For researchers, similar soils that have been subjected to different land use trajectories can also be regarded as 'field experiments'. In embarking on such ventures it is essential to remember that the perceptions of farmers about their soils and their behaviour may differ from those of the researcher (Bouma 1993; Garlynd *et al.* 1994; Harris and Bezdicek 1994). For example, soils often have local names, which, in many cases, are expressions of the more holistic approach of local farmers compared to scientists²⁴. This approach has been described as 'art de la localité' (van der Ploeg 1991) or 'the art of the specific'. It involves a degree of craftsmanship; the ability to combine the specific elements of a farm such as animals, soils, crops and technology into a 'working whole' (Roep 2001). Local knowledge forms in essence the vehicle for integrating and co-ordinating the elements that exist within the farm system and farmer's labour acts as the linking agent, coordinating the various farm components and balancing them in relation to each other (van der Ploeg 1991). Agricultural enterprises are a unique integration of natural phenomena and human activities that are transformed into a working agro-ecosystem. In contrast with researchers, local people may think of a soil, not so much as 'something out there' but more as 'something inside' (Sillitoe 1998). Mendras (1970) reported from his research that

'the farmer felt as if he 'made' his field and knew it as the creator knows his creation, since the soil was the product of his constant care; ploughing, fertilising, rotating crops, maintenance of fallow ground and so on'.

The assemblage of fields within a farm, become a unified working whole through the decisions and activities of the farmer. Through his selection of fields for different purposes and exerting his 'freedom' to apply different forms of management on different fields and at different times, the farm becomes a unique configuration of characteristic land units and land use. The specific combination of social, material and natural elements and the interrelationships between them, expresses a 'farming style' (van der Ploeg 1999). These appear as an expression of a coherent set of strategic notions about the way in which farming should be practised. This implies that, for local people, knowledge about the soil is part of a broader domain of knowledge. It is contextual, locally embedded within a cultural repertoire²⁵.

Changes in soil and landscape properties that have been brought about by past activities can affect both the awareness and the ability of the farmer to build new strategies. This is often expressed or perceived through characteristics that are not normally included within standard research enquiries although they do relate to recognisable land and soil quality parameters. For example, one farmer in the Friesian Woodlands said that

he decided to minimise use of ploughing in grassland renovation because one of his fields felt like 'concrete', rather than resilient, after ploughing. This indicates how farming activities are often informed by a degree of reflection and looking back at past results. Tasks are continuously observed, interpreted, evaluated and adjusted (van der Ploeg 1987). Dairy farmers who did not follow the trend of frequently renovating their pastures (and were seen as 'old-fashioned') now find that they are considered to be 'modern' farmers, as their grassland management strategy meets requirements for lower emissions to groundwater.

5.2 Soils and co-production

The term co-production refers to the on-going interaction between farmers and living nature resulting in their mutual transformation (Gerritsen 2002; Renting and van der Ploeg 2001; Roep 2001; van der Ploeg 1999). Co-production influences the characteristics of farming, natural resource management and living nature (Roep 2001). Within this framework, the soil is both the result of an interaction between natural processes and land use practices, and influences future land use decisions and biophysical processes.

In contrast with other components of agriculture (such as technology, crops and animals) that can also be considered from a co-production perspective²⁶, the soil is non-transferable. It is at the roots of the locality and is specific to the field, the farm or the region. It influences farming in a number of ways, through e.g. the specificities of technology, crops and management practices. Yet at the same time it is influenced by these practices. Specific landscapes can, for example, be regarded as outcomes of co-production (Faber *et al.* 2000; van der Ploeg 1999), as results of continuing encounters and mutual transformation between man and nature. Land and landscape do not merely form the physical backdrop for human action but are the result of, and canvas for, a whole set of complex connections. People are generally connected to the landscape in which they grew up, which often contributes to an individual's sense of identity and feeling of belonging. Rölöing and Maarleveld (1999) refer to this as the 'soft side' of land, which reflects past interactions between people and land, in terms of organisation, religious beliefs and cultural practices²⁷. In the future, these facets will influence individual and societal decisions that are taken about the development (or preservation) of these landscapes as well physical characteristics, such as nutrient flows, that occur.

In a narrower sense, co-production is also a part of agriculture. Land use practices influence land properties and these changing properties in turn influence the knowledge and behaviour of the land users. Land use is not simply a set of technical operations and artefacts, rather it is an emergent property of the interactions between the land and the society that lives

from it. Natural limits on land use activities may exist because of, for example, geological and geomorphological conditions but can be reduced, removed and altered by human resourcefulness. The 'hard' way in which land and land use often been conceptualised is not so rigid at all. There is space to diversify or, more poetically, to *unfold*. It is possible to create specific expressions of the land and the soil. One farmer, again cited by Mendras (1970), expressed this idea this way: 'to know one's land, to improve it, takes a long time. The more you know it, the more you become attached to it'.

Izac and Swift (1994) regarded the unfolding material outcomes of the soil as *by-products* of agriculture, distinct from the general variety of agricultural *products*, such as animals, crops, fruits and medicines. Useful though this conceptualisation is, it does not sufficiently stress that such a by-product is also re-used within the farming system. Specific soils are an output of, and at the same time an input for, agriculture. In (semi) closed farming systems *all* products are inputs to the farming system through e.g. breeding with animals or producing seeds with plants. In other words, there is a continuous production and reproduction.

Droogers and Bouma (1997) have proposed a dual classification of soil systems; covering; *geno-phorms*, the taxonomically defined soil series, and *pheno-phorms*, the results of different types of management or land use. The later category would allow for specific expressions of a soil series that are related to land use history. Their work builds on the concept of the soil series as defined in Soil Taxonomy (Soil Survey Staff 1975). This later conceptualisation of soils serves as a vehicle to transfer information and research knowledge about soils from one area to another. In other words soil series are conceptual groups (Arnold 1983) that encompass a whole set of real soils (polypedons) which have evolved under different land use practices. Thus soil series can act as carriers of land use history.

5.3 Re-balancing co-production: a spatial perspective

The suitability of soils for grassland production cannot be unambiguously assessed solely on the basis of their biophysical properties²⁸. The same is true when seeking to evaluate the potential for nitrate and other forms of leaching. Their *spatial* context also plays an important role in this. For example, a field containing mostly good soil types, may be valued differently if it contains a poor soil type within its boundaries. A farm where poor soils cover only a small percentage of the total surface will be viewed differently to one where poor soils cover a substantial area. On the other hand, the occurrence of only a small area of a high productive soil on a farm with mostly rather poor soils may influence the farming system dramatically in comparison with a similar farm that has only poor soils²⁹. Land use can be spatially differentiated to fit the spatial heterogeneity within field or farm boundaries. This ability to exploit the spatial

heterogeneity of soils and arrive at a better 'working whole' gives the land its agricultural value. Farmers can follow different strategies in their enterprise and often will apply different types of management to specific fields. In consequence, soils may follow different land use trajectories due to the farmers' strategy or the location of the field with respect to the farm buildings. Thus, at the farm level, there is a dynamic interaction between the integrating and coordinating activities of the farmer (through his labour) and the processes in the soil. So not only do intersections occur between natural land units and the spatial units (fields) of the farm, but there is also an entanglement of land use with soil processes. Implicitly, the assessment of the suitability soil is not only dependent on local factors, but is also influenced by the characteristics of surrounding soils.

At a regional level, agriculture does not exist merely as a collection of inert and independent farms. They share (and form) a common landscape with similar natural resources and a cultural repertoire. In Europe, this has expressed itself in regionalised farming styles with specific farming techniques, regional products, local breeds and architecture (Renting and van der Ploeg 2001). At this, the regional level, the land also exhibits a degree of underlying dynamic interconnection, mostly by means of hydrological processes. Soils are contextual, even from a 'natural' point of view. They experience inputs (run-on) from upslope areas or undercutting from adjacent rivers. They act as intermediates between precipitation and the quantity and quality of surface waters. The effects of human influences on natural soil processes thus extend beyond the soil system itself. Landscape processes carry these influences across boundaries of basic agricultural units, such as fields and farms. The natural environment provides structure, containing natural agents and influences how fields or farms affect one another, nature conservation areas or surface waters³⁰. Farmers share these common resources, which suggests that collective action needs to take place in order to maintain their sustainable use. Collective action can be pursued through geographic communal bodies, such as regional environmental cooperatives. Such organisations may well provide an attractive economic and agronomic alternative to rigid restrictions on land use to address problems such as nitrate leaching (e.g. Worrall and Burt 2001).

Soils that are the outcome of a specific land use trajectory may require the adoption of specific farm management strategies (or rejection of others). For example, it has been shown that long term organic farming leads to higher organic matter contents that can result in better soil structure, but only with specific management. Soils such as these are more at risk of being compacted by tillage, vehicular traffic or grazing under wet conditions. In other words the land use history of soils, channels management practices in specific directions, which may in turn require

the use of specific technologies³¹. The development and existence of a particular expression of the soil (i.e. the *phenoform*), pre-supposes the co-development and existence of other practices or artefacts. This leads us back to the notion of working configurations, assemblages of different aspects of the farm that are mutually fine-tuned.

There is an increasing amount of empirical and theoretical evidence that soils and landscapes reflect agricultural activities and that these in turn influence future land use trajectories. These trajectories cannot be (re-) constructed on experimental fields or farms. It can often take decades to achieve equilibrium conditions, which would make it impractical and too costly to perform this type of research, especially on a range of soil types. Moreover, the technology or management practices that are needed to replicate these specific trajectories of land use, may not be easily found outside the context of the individual farm.

It is increasingly being realised that classical soil suitability approaches and land evaluation procedures do not account for the dynamic relationships between land users and their environment. The concept of *genofoms* and *phenofoms* helps enlarge the horizon of soil science and offers the opportunity of aligning research activities with local practices. It is to be hoped that researchers and local farmers can meet this challenge and work together in developing more sustainable agricultural systems.

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Notes

1 See also Chapter 1 for a more detailed description on the Law of the Minimum or for example van der Ploeg *et al.* (1999).

2 This actually follows from one of the assumptions behind the development of Soil Taxonomy in the United States.

3 Although at the time of the publication of the Dutch system of soil classification (De Bakker & Schelling 1966), the need was felt to include such considerations.

4 This was part of the modernisation process of Dutch agriculture (van der Ploeg 1987).

5 Soil suitability is traditionally defined as 'the degree of success with which a crop or range of crops can be regularly grown on a certain soil, within the existing type of farming, under good management, and under good conditions of parcellation and accessibility'. See also Vink and van Zuijlen (1974).

6 Interactions between the land use and the soil are then excluded for the purpose of simplification. For a more detailed discussion see e.g. Beek (1978).

7 See Stuiver *et al.* (this book) and Reijs *et al.* (this book).

8 This study was performed at the request of the Dutch Ministry of Agriculture, with the specific aim of addressing the '*problem of intensification of small farms*'. At the time, the area was predominately grassland, but it was recommended that large-scale conversions of grassland into arable land, especially in the higher parts of the landscape, would be necessary to secure a '*healthy foundation of the small farm*'.

9 For detailed information on their origin, properties and distribution, the reader is referred to Conry (1974), Creutzberg and de Bakker (1988), Edelman (1952) and Pape (1970).

10 According to Veenenbos (1954), this may well have been the main purpose of this intervention.

11 The Dutch soil classification system made extensive use of local names. The soil names that were introduced at the lowest level of the classification system were a combination of scientific names and the name of the locality where a specific soil was prevalent. Soil conditions, land use and reclamation history all influenced these local fieldnames (Schönfeld 1950). In this case, 'Laar' refers to an open place in the woods and was as a name for reclaimed areas in the Middle Ages.

12 Of particular concern was the effect that soil compaction would have on the rooting potential of the crop, which could lead to a potential yield drop of more than 15 per cent.

13 For the Netherlands, see Minderhoud (1959) on the desirability of grassland renovation to overcome the years of depression.

14 The difficulties of creating (and maintaining) highly productive pastures are traditionally widely recognised. Hoogerkamp (1984) quotes the saying '*to break a pasture makes a man, to make a pasture breaks a man*'.

15 The issue of biodiversity has recently received special attention as the ploughing of old pastures may lead to a significant loss in genetic diversity. See also Janssens *et al.* (2002).

16 Also known as *blue-baby syndrome*

17 It was recently reported that for the upper groundwater in the sandy areas in the Netherlands, the average nitrate concentration for the period 1996-2000 was twice the standard in the Nitrates Directive (RIVM 2002).

18 The loss of nitrogen from agricultural systems through nitrate leaching can however not be viewed in isolation from the whole nutrient cycle at dairy farms (Carton and Jarvis 2001, Jarvis 2000 and Ryden 1984). Other related environmental concerns are Ammonia (NH₃), Nitrous oxide (N₂O), Phosphorus (P) and Methane (CH₄). Most recent studies have therefore adopted a farming systems approach (e.g. Van Bruchem *et al.* 1999). See also Goss *et al.* (1995) who argue that restrictions on farm management addressing single issues may not always be suitable in a local context when the whole farming system is considered.

19 The major soil types came from the then available guidelines on nitrogen fertilisation where soil types were differentiated on the basis of their nitrogen supply capacity. These are not the same as the soil types that are distinguished in the Dutch soil classification system.

20 For more background information on the development of the final loss standards, the reader is referred to Dekker and van Leeuwen (1998) and Schoumans *et al.* (1998). These publications provide more insight into the issue of a rational development of loss standards. See also Frouws (1994) for a long-term overview on manure policy. For specific information on the whole Dutch legislation on manure and fertilisers in relation to the Nitrates Directive, the reader is referred to Henkens and van Keulen (2001).

21 Dry sandy soils being defined as soils where the groundwater table is on average between 40cm and 120cm below the surface. This corresponds with groundwater classes VI and higher.

22 These included limits on: the periods for using animal manure and artificial fertiliser; the use of animal manure on sloping fields and; the periods where grassland ploughing is

allowed. Specifically, grassland ploughing is prohibited in the period from September 16th until January 31st.

23 Soil organic matter content is also greatly influenced by the local hydrological conditions (past and present). If groundwater class data is taken into account, around 75 per cent of the total variation in soil organic carbon content and 59 per cent of the variation in nitrogen in the topsoil can be explained by land use history.

24 In the field of ethnopedology, special attention is given to the documentation and understanding of local approaches to soil perception, classification, appraisal, use and management. For further reading see WinklerPrins (1999).

25 See Stuiver *et al.* (this book) for a more elaborate discussion of the differences between local knowledge in general and scientific knowledge.

26 See van der Ploeg *et al.* (this book,).

27 Many ancient cultures did not see the land as solely a capital or a means of production. In many cases, spiritual values were attached to the land and a deep sense of connection was felt and expressed (see e.g. Kellog 1941 and Hillel 1991). The same holds true in many parts of the 'under-developed world'

28 For more detailed information soil suitability classification and land evaluation, the reader is referred to Vink (1959 & 1963), Beek (1978), Bouma (1989 & 2001). See also Veldkamp *et al.* (2000) for a background on multi-scale approaches.

29 The example originally comes from an observation of Kellog (1941) and refers to the notion of *soil pattern*. In the Netherlands, this aspect has been referred to as 'kaartbeeld'. The mixed farming system, characteristic of large parts of Western Europe, provides an example of how soil heterogeneity was exploited in a way that led to a type of agriculture that was sustained for centuries. Although the concept of soil patterns has long been recognised it has, surprisingly, hardly been systematically studied.

30 These 'off-site' effects are often major issues in debates on environmental quality, especially in the tropics.

31 The small-scale landscape of the Friesian woodlands, with its small fields did not match with the heavy and large machinery that was needed for injecting manure into the soil. The technology was not adapted to the land and there was a perceived threat of damage to the structure of the soil. As a consequence, local farmers developed their own machine (called the 'area friendly machine'), which fitted better in small fields. See Eshuis *et al.* (2001) for a more detailed report on the development of this machine.

8 Small-Scale Farming in KwaZulu-Natal: Experiences from some 'Promising Pockets'

Samantha Adey, Donovan C. Kotze and Frits H.J. Rijkenberg

1 Introduction

Agriculture in the former homelands of South Africa is generally perceived as 'subsistence' and is extremely marginal in terms of the commercial-dominated agricultural sector (Bembridge 1990). Yet, it continues to play a part in the livelihoods of large numbers of households, involving substantial numbers of farmers (Cooper 1988). The transformation of South African agriculture in the post-apartheid era is faced with the challenge of designing new remunerative options for small-scale farming systems that improve family food security and create new employment opportunities for historically disadvantaged people.

In South Africa, large-scale commercial farms have been seen as the predominant model for farming success. The capacity of agricultural service providers to support the emerging sector of small-scale farmers is still relatively low. Alternative, more ecologically orientated, agricultural systems, which typically combine smaller-scale farming practice with a diversity of crop and stock varieties, and soil and water conservation practices, are far more widely practised in many other African countries than they are in South Africa (Turner 1998). In this country, ecological approaches to agriculture have traditionally been viewed as synonymous with subsistence agriculture, rather than as a possible route for income generation.

KwaZulu-Natal province contains some of the most intensively developed large-scale farms (that could be described as 'overdeveloped') in the country, as well as some of the poorest 'underdeveloped' areas. Nevertheless, some promising examples of sustainable small-scale farming systems can be found in the province, although the opportunities (and constraints) to develop these farming systems need to be seen against the background of the apartheid system, old and new Agriculture and Land Reform Policies, provincial agricultural policies, the biophysical environment of small-scale farming, the social and cultural context and agricultural research and extension.

Before discussing some promising experiences in developing of small-scale farming systems, we will first give a brief description of the agricultural production potential in KwaZulu-Natal followed by a thorough description of past and present developments at national and local level, which constrain or enable the development of small-scale farming systems.

2 KwaZulu-Natal Province and Agricultural Production

KwaZulu-Natal (KZN) is one of the nine provinces of the Republic of South Africa, and has a total area of 9,210,000 ha. Of this, 30.3 per cent is suitable for dryland cultivation, 12.7 per cent has a high potential for dryland cultivation, and 15.9 per cent is currently under cultivation with 1.2 per cent under irrigation. Natural vegetation, excluding Nature Conservation Areas, occurs in 60.4 per cent of KZN, with 10.1 per cent designated as Areas of Nature Conservation. KwaZulu-Natal has a population of 8,577,000 people (21% of the South African population), of which 5,300,000 (62%) live in rural areas (Anon 1996). There are an estimated 400,000 rural agricultural land user households (i.e. black farming families).

The diversity of natural resources in KZN is enormous. Variations in altitude, which ranges from sea level to over 3000m, results in a considerable range in temperatures. The topography varies from the undulating coastal plains of Maputaland to the rugged, broken terrain of the Valley of a Thousand Hills and the precipitous mountains of the Drakensberg (Camp 1997).

Rainfall variations (mean annual from 600 to 2000mm) and a variation in the distribution of rain over the year, temperature variations and soil variations have resulted in a diverse and intricate vegetation pattern (Anon 1996). Savannah is found in the low-lying hot and dry areas of northern KZN and in most of the river systems. In the northern plains of the province tall grassland is characteristic, while in the cold highland areas the grassland is typically short (Camp 1997).

Soil variations include deep sands along the northern coastal belt, young weathering soils in the steep valleys, well-drained, deep soils in the midlands and the highland areas and poorly drained duplex soils in the upland areas with rainfall below 750mm per year (*ibid.*).

This great variation in natural resources in turn leads to variations in the type of farming and levels of production throughout the province. KwaZulu-Natal has long been recognized as the 'food basket province' in South Africa, particularly with regard to vegetable production and dairy farming. However due to the high humidity along the coastal areas and the relatively high rainfall in the central midlands region, there is also a

high risk of plant disease in these areas. Viruses are prevalent along the coastal belt and fungal diseases are a continual curse during the summer months in the midlands. So, although farmers can expect high yields due to ideal climatic conditions, these are often offset by loss of yield due to disease.

3 Agriculture and Land reform

Prior to (the declaration of) the apartheid era, black people in South Africa were confined to native reserve areas, known as homelands. In 1936 the total reserve area was 13.8 per cent (6.21m hectares) of the national area. Under apartheid the process of homeland consolidation continued into the 1980s. By 1980 homelands covered 20 per cent of the national area and supported 11 million people (Wilson 1991). It was impossible for black Africans to own land in the white farming areas and measures were taken to impede black agricultural production on white-owned farmland, driving black farmers out of the commercial farming areas. Many households became reliant on incomes from migrant labour in towns and mines.

The agricultural policies of the apartheid era in South Africa reflected a biased concern towards white-owned commercial farming units. The White Paper for Agriculture in 1984 stated that a '*maximum number of financially sound owner-occupant farms*' was an important aim of the policy as it would '*contribute to the retention and establishment of a stable, happy and prosperous rural population*' (Anon 1984). This largely excluded the homelands, which were far from being financially sound.

Almost all of the land in the former homelands of South Africa is held under 'communal tenure', which combines elements of individual and collective property rights. It is communal in that an individual's entitlement to land flows from membership of a socio-political community (e.g. a tribal unit), rather than from private ownership but production is generally on an individual basis (Bennett 1995).

Communal tenure is managed by Tribal Authorities through tribal chiefs and headmen, who survived the transition to democracy with their powers virtually intact, although, their powers currently are gradually declining. In KwaZulu-Natal, however, the system still enjoys a relatively high level of legitimacy.

Every household within a communal area has, in principle, a right to a residential site, an arable plot for crop production, and access to common property resources, such as grazing. In practice, however, a substantial proportion of people in communal areas have little or very meagre access to land (Simkins 1981; Lahiff 2000). The right to land usually applies only to male 'household heads' but is sometimes extended to women (Bennett 1995). Those who obtain land receive a right to its permanent use, but not to sell it. Unallocated land is generally used as commonage, providing

pasture for livestock and other natural resources, such as timber, grass and sedges for craft production, thatching grass, edible fruits and plants and materials for use in traditional medicine (Cousins 1996). Tribal leaders have the power to repossess allocated land but *very* seldom do so, and the communal system is generally seen as a reasonably secure form of tenure (Bromberger 1988; Lahiff 2000). While major dismantling of the current 'communal tenure' system would be inappropriate, reform of the tenure system is clearly required to account for changing socio-political circumstances and to address issues such as the inherent gender bias of the current system.

The first ANC-led government faced the challenge of redressing land injustice without risking the collapse of the nation's commercial farming sector. It has adopted a broadly neoliberal approach to economic policy and avoided many of the demands of its more radical supporters for nationalisation or expropriation of white-owned land (Lahiff 2000). The Land Reform Programme was initiated to address the highly controversial issue of land ownership and access to land. It aimed to return land to those denied land based on racially discriminatory laws and to transfer ownership of land in the former homelands from the state to the people who live on that land and have legitimate right to it. The Land Reform Programme has three key elements: land restitution; land redistribution and land tenure reform.

Restitution refers to the direct return to the previous owners of land and property that had been removed due to racially discriminatory law or practice. The types of property loss that land restitution seeks to redress are clearly specified in the restitution of Land Rights Act (Act 22 of 1994). By the deadline of 31 December 1998, a total of 67 531 claims were registered, although it is suspected that many valid claims were not submitted as people did not know about, or did not sufficiently understand the process (Turner and Ibsen 2000). To date, 10 per cent of the claims have been settled. Approximately 80 per cent of claims are for urban land and many involve the payment of financial compensation rather than the return of land. Restitution offers no assurance with regard to livelihoods, as there is no effective link between restitution and development (Turner and Ibsen 2000).

It was anticipated that market-led, demand-driven, state-supported redistributive land reform could achieve political and equity goals, and create strong economic growth in the agricultural sector and start to transform South African farming into small, efficient black-owned family farmers. This would involve the redistribution of 30 per cent of white-owned land to over 800,000 black households in five years at a cost of ZAR17.5 billion (Williams *et al.*; 1996). Agricultural production was assumed to be the core function and purpose of redistributive land

reform, although residential land use was also acknowledged as a goal (Anonymous 1997). Cooperation between the National Department of Agriculture and the Department of Land Affairs (DLA) was poor and there was little collaboration or integration of land agrarian reform efforts. Provincial Departments of Agriculture (PDAs) needed to cooperate with the DLA, which was problematical due to logistical difficulties, the PDAs' inexperience, lack of capacity and ideological hostility (Turner and Ibsen 2000). Although support mechanisms helped beneficiaries acquire their land, little 'post-transfer advice' existed for potential farmers. The long-term support and extension services would need to come from the Provincial Departments of Agriculture. This merely served as a reminder of how little capacity there was in the PDAs to support small-scale farming. Compounding this was the fact that not many 'beneficiaries' showed serious farming intentions. It was clear that the redistribution challenge was much more complex and long-term than had initially been thought (*ibid.*). Despite early difficulties, the programme made progress in achieving secure access to land for many poor South Africans. By August 2000, 340 redistributions (to 55,383 households) had been carried through to land transfer (*ibid.*)

Land tenure reform was a method whereby the Department of Land Affairs (DLA) aimed to transfer ownership of land in the former homelands from the state to the people who live on that land and have legitimate rights to it. The transfer of ownership was complex and difficult, arising from the lack of fit between the exclusive nature of the Western concept of property ownership, and the inclusive, flexible and nested character of many African systems of property rights (Cousins 2000). The tenure system in South Africa has already demonstrated a striking capacity to adapt to economic change in areas where economic incentives are strong, but without an economic space into which the rural economy can expand, no amount of tenure reform will be able to produce real results (Cross *et al.* 1982). As yet no substantive tenure reform had been achieved for the former homelands.

In the second democratic election in 1999, Ms Thoko Didiza was appointed Minister of Agriculture and Land Affairs. Since then, there has been some acceleration in the restoration of lost rights through land restitution but there is little prospect of restitution being built into a broader process of enhancing livelihoods or achieving sustainable development. The Minister's new policy emphasis on helping black Africans gain entry into commercial farming should mean a significant expansion of the black large-scale farming class in the future. But most sub-sectors of South African agriculture are in poor economic shape at present and many existing farmers are leaving agriculture. The land redistribution model turned out to offer little scope for sustainable small-scale agricultural growth and South Africa continues to lack the technical

expertise and available information to support small-scale farming. Thus, there is little prospect for the rural poor to improve their farming methods and enhance their income from agriculture through land and agrarian reform.

A core problem is that land and agrarian reform has not been part of a broader, integrated rural development process. Rural development efforts suffer from fragmentation and lack of a coherent programme or agency at both the national and provincial level. At present, land and agrarian reform show little sign of effectively addressing the deepening crisis of the rural poor, who remain marginalised by the process of economic growth (Turner and Ibsen 2000). Wildschut and Hulbert (1999) emphasised that the government has adopted a low-key welfarist, rather than a productive approach, to rural development. This is based on the government's belief that urban-based growth will somehow trickle down to the rural areas, which has largely not taken place.

4 Agricultural Research and Extension Services within KwaZulu-Natal

Land ownership is only one of the many complex issues facing emerging farmers in KwaZulu-Natal and the other South African Provinces. The role of the Provincial Departments of Agriculture (PDAs) also plays a significant role in determining the potential of emerging farmers to succeed in agricultural production. We will briefly outline the current research and extension services available to small-scale farmers by the KwaZulu-Natal Department of Agriculture and Environmental Affairs (KZNDAEA). A number of non-governmental organisations (NGOs) active in KwaZulu-Natal also provide much needed extension services to emerging small-scale farmers (see Section 5.1). However, as the KZNDAEA services are more widely spread, more visible and thus more open to critical comment, they will be the focus of discussion, after a brief history of extension in South Africa.

The commercial farming sector in South Africa has been served by extension services since 1924. The main tasks of the extension workers were the selection of breeding livestock for farmers and the provision of services to farmers' associations and show societies. Due to the limited impact at the time of educational films, lectures and demonstrations, whole-farm demonstrations were initiated and were more successful in *stimulating* the adoption of new farming methods (Bembridge 1990).

In the 'homelands', few demonstrators were appointed before 1910 to *teach* improved cultivation to small-scale farmers (*ibid.*). It is interesting to note that historically, commercial white farmers and black small-scale farmers have been treated differently with regard to the content of extension services and methods (stimulation *versus* teaching) by which extension services have been implemented.

From 1949, after the establishment of an Agricultural Division, the focus of extension work was on irrigation farming, physical development, soil conservation works, planning of arable lands, development of stock watering points, fencing and tree planting. After reorganisation in 1962, an in-service training programme for extension staff was established and the role of extension staff was reorganised, development work was divorced from extension and areas were demarcated as extension wards each to be serviced by an extension officer (*ibid.*). These extension wards, serviced by an extension officer, still exist today.

Extensional personnel in the former KwaZulu (homeland) areas have the hardest task as they deal with small-scale farmers who have not had the legacy of support of continued government research and extension services. Extension workers have a poor reputation in the more isolated areas and are perceived as being paid for doing nothing. Stories abound that they stay at home and only go out when they choose, and some even expect to be treated as if they are chiefs, receiving gifts before they will perform their functions (Greenberg 2000). PDAs face a growing problem in managing their extension services. Due to budget cuts and the loss of skilled staff to resignations and voluntary severance packages, they are forced to make do with less and less. Budgetary restrictions and the lack of suitable candidates to fill vacated posts means that some departments have to do without engineers, veterinarians, agricultural scientists, economists and skilled, experienced administrators (Greenberg 2000).

Many of the problems that extension workers encounter are related to agriculture, but are not directly associated with improving agricultural production. For example, commercial farmers require services related to the dose-response of crops to fertilisers, whereas small-scale farmers are more concerned with how to purchase fertiliser on a low income (for example a pension) and how to transport it from the depot to their farmland.

There has been a positive move by the Farming Systems Research section of the KZNDAEA to address the needs of small-scale farmers, through the establishment of a farming systems demonstration unit focussing on small-scale enterprises. The Farming Systems Research Unit also conducts trials with farmers on their fields, primarily in maize production. The Soil Science section is addressing soil fertility constraints by investigating the use of chicken litter to address soil nutrient imbalances. This research is currently conducted on the research farm but will also be conducted in farmers' fields.

Government-supported agricultural research has been overwhelmingly concentrated on the commercial, high external input sector, and even the NGOs that are focussed on small-scale farmers, have placed a low priority on documenting the experiences of these farmers.

University research within KwaZulu-Natal to address the needs of small-scale farmers has largely focussed on the development of 'appropriate' technologies on research farms. These technologies include: tread mill water pumps; improved crop varieties; reduced tillage planters; and feed intake programmes for chickens, goats and cattle. The transfer of these technologies to the intended audience has not always been successful and a need exists to develop technologies with farmers. With this in mind, the University of Natal has launched its Centre for Rural Development Systems, which aims to create a seamless continuum between the University's teaching, research and extension personnel and the small-scale farmer. While directly assisting the small-scale farmer, the University also intends to provide its students with a more relevant training programme.

There remains a dichotomy within the agricultural sector and the associated assistance provided for commercial and small-scale farmers. The Mandela Government gave support to subsistence farmers and they were in some ways the focal point of assistance to the 'new' agricultural sector. The Mbeki government on the other hand has shifted focus more to assisting emerging farmers (those who intend to become commercial farmers). So in many ways, the agricultural services provided by government departments are directed towards the needs of a relatively small number of small-scale farmers, while almost ignoring the plight of the majority. . It appears that once again, the problem of the poorest farmers is left to NGOs.

As mentioned above, there are many different actor organisations with a great diversity of underlying motives (objectives) for intervention in the agricultural production of South African small-scale farmers. These objectives, which shape and define the role played by the different actors, include the following.

- 1 Promote commercialisation and profitability of production.
- 2 Facilitate the transfer of agricultural land to black people, who have been disadvantaged by past injustices
- 3 Enhance food security
- 4 Alleviate poverty
- 5 Promote the ecological sustainability of production.

These objectives overlap to varying degrees, with some (e.g. food security and poverty alleviation) re-enforcing each other. Others, however, are potentially in conflict (e.g. focussing resources on promoting promising emerging black commercial farmers rather than spreading resources to reach as many poor farmers as possible in an effort to promote food security and farming as a sustainable livelihood intervention).

The various actors obviously vary according to the emphases they place on these respective objectives. The sugar industry, for example, has been relatively successful in increasing the commercialised production of small-scale farmers through their 'Out-growers Programme'. Over 30 per cent of South Africa's commercial sugar production is now by black farmers, whose contribution has been increasing progressively over the last few decades. However, the ecological sustainability of production is relatively low, involving high external input, and the application of inorganic fertilisers, herbicides and pesticides. Sugar production has also had a very limited contribution to increasing the food security of rural communities, which is understandably not its focus.

In contrast, NGOs have tended to focus mainly on enhanced food security, which they have done successfully in the areas within which they operate. However, they have been unable to offer much assistance to emerging farmers wishing to expand their remunerative production and access external markets. Government departments are caught between trying to satisfy all of the above objectives, as well being subject to the shifting priorities of politicians. Generally, the KwaZulu-Natal Department of Agriculture and Environmental Affairs (KZNDAEA) has interpreted sustainability in a fairly narrow sense, with short-term gain based on high external input agriculture being held up as the most productive and desirable option for which to aim.

In response to the KZNDAEA's general insensitivity to local technologies and ecological requirements, NGOs have tended to work fairly independently of government in developing alternative approaches, and only recently are opportunities developing for joint exploration and learning. A fairly negative 'us and them' attitude has developed amongst individuals in both 'camps'. It appears, however, that a shift in the government approach, at least at a policy level, is taking place, which is creating a more enabling environment. An important development is the national government's recently initiated LandCare initiative. The vision of the LandCare Programme is:

'to have communities and individuals adopt an ecologically sustainable approach to the management of South Africa's environment and natural resources, while improving their livelihoods. This means people use the soil, water and vegetation resources in such a manner that their own quality of life is improved and that future generations will also be able to use them to satisfy their needs.'

Although the Programme is certainly not without teething problems, it presents many opportunities. It has already had active participation of many NGOs, and provides a useful means for increasing the level of collaboration between government and NGOs in supporting small-scale farmers.

A number of demonstrations and training courses are available to small-scale farmers. Training includes both high and low external-input methods, with low-external-input training based on predominantly organic, sustainable and conservation farming techniques. The PDAs provide high-external-input training in crop and animal production systems. University-affiliated courses provide training on mixed input methods for crop and animal production systems on demonstration farms. NGOs provide sustainable, organic low-external-input training in crop and small-animal production systems using a hands-on approach and working examples.

We will now discuss some 'promising pockets' of small-scale farming within KwaZulu-Natal, identify possible and existing entry points for applied research and extension, the impact of existing agricultural and land reform policies and frameworks, and the prevailing socio-economic climate.

5 Some 'Promising Pockets' of small-scale farming in KwaZulu-Natal

5.1 The Valley of a Thousand Hills

The Valley of a Thousand Hills lies to the north west of Durban. Due to urban sprawl in the region, the area is not deeply rural (by African standards) and some wards could be classified as tending towards peri-urban. Many homesteads have access to electricity and piped water, but no sewerage system is in place. Most wards in the area are linked to the surrounds by a well-developed infrastructure of roads (some tarred), serviced by taxis and busses.

A non-government organisation, the Valley Trust has been assisting people in some areas of the valley since the 1950s, following the establishment of a primary health care facility as an intervention to promote good health. It was realised that the health of the communities that the clinic serviced was poor, because of nutritional deficiencies. The vision of the organisation was broadened to include food production to ensure that the people of the valley were adequately nourished.

The Social Plant Use Programme (SPUP) of the Valley Trust actively assists potential and existing farmers to overcome constraints to food production. The programme is based on organic methods of production within the paradigm of low-external-input sustainable ecological agriculture (this being identified as the safest means of producing the most nourishing food). It also fills a gap in support as extension personnel from KZNDAEA already support farmers wishing to use chemical means of production.

Crop Production

In summer, the area around the homestead is planted to maize, beans and pumpkins. These are often planted in a mixed system, with plot size

varying from 0.5 to 2 hectares. Some vegetable crops are grown in the summer months but most vegetables are grown in abundance in autumn and winter. A communal area that is fenced-off and secure from foraging animals is often used for growing vegetables. As fencing can be a major financial cost, an area is fenced 'communally' forming what is known as a community garden. A committee is established and the members of the garden contribute a certain amount for the purchase of seeds, seedlings and in some cases, the fence. Sometimes the PDA assists with the cost of providing fencing. Community gardens are usually situated some distance from the homestead. The chief, or a resident with some land to spare, often donates the land. As a result the community gardens are frequently situated on poor soil, and in many cases in wetlands (Adey *et al*; 1998). As these community gardens are often distant from the homesteads and this reduces the time that members can spend on their plots, and weeding and watering is not done so frequently. For the same reason, and despite the fencing, theft of produce is also common. Also the interest of members in maintaining a plot can fluctuate, for a variety of economic and social reasons. It is not therefore, uncommon to see plots in the community garden lying fallow. .

Extension officers, under direction of KZNDAEA, assist the members of formal community gardens with vegetable production. This assistance may be in the form of recommending vegetable varieties; providing seeds or seedlings; testing soils for fertility status, or establishing the amount of fertiliser needed to balance soil nutrient status. A fairly constant range of vegetables is grown in the community gardens, with the only variations being due to climatic constraints.

The Valley Trust's SPUP was initially active with some community gardens whose members were unable to purchase the inputs promoted by the KZNDAEA as 'best practice' for vegetable production. These inputs included fertiliser, seedlings and improved vegetable varieties. Due to the prescribed methods of crop production and crop varieties within these community gardens, the SPUP realized that the potential of the community gardens was being constrained and they started exploring the potential for diversification and the inclusion of traditional varieties or indigenous crops. These traditional crops and varieties are ideally suited to the local climate and can thus produce an adequate yield. Also, the seeds of these traditional crops can be selected and kept each year for the next crop, which has important implications for sustainable production: helping the farmers save money; to preserve traditional crop material and; to affirm indigenous knowledge and culture. Within four wards of the Valley of a Thousand Hills, farmers who are assisted by SPUP still grow traditional varieties, some of which are listed in Table 1 together those varieties more commonly grown in community gardens.

Table 1 Some introduced vegetable crops (community gardens) and traditional crops (homestead gardens) grown by small-scale farmers in the Valley of a Thousand Hills, KwaZulu-Natal

<i>Introduced Vegetable crops</i>	<i>Traditional crops still grown</i>
Green beans (<i>Phaseolus vulgaris</i> L.)	Dry beans (<i>Phaseolus vulgaris</i> L.)
Irish potatoes (<i>Solanum tuberosum</i> L.)	Sweet potatoes (<i>Ipomea batatas</i> Poir.)
Beetroot (<i>Beta vulgaris</i> L.)	Madumbes (taro) (<i>Colocasia esculenta</i>)
Onions (<i>Allium sepa</i> L.)	Sorghum (<i>Sorghum bicolor</i> L.)
Carrots (<i>Daucus carota</i> L.)	Yellow maize (<i>Zea mays</i> L.)
Swiss chard (<i>Beta vulgaris</i> L.)	Gourds (for beer, milk) (<i>Cucurbita</i> spp. L.)
Cabbage (<i>Brassica oleracea</i> L.)	Izindlubu (<i>Vigna suberranea</i>)
Chillies (<i>Capsicum annuum</i> L.)	Pumpkins (<i>Cucurbita</i> spp. L.)
Tomatoes (<i>Lycopersicon lycopersicum</i> (L.) Karst.)	Imfino (spinach) (<i>Amaranthus</i> spp. L.)

Community gardens do provide locally produced fresh vegetables at reasonable prices and the growers are able to augment the family budget through selling surpluses (Crosby *et al.* 2000). They also provide a place where people can learn from each other and share ideas and they have valuable social functions, such as providing a place where new wives can get some peace from the mother-in-law (Shezi, *Pers. Comm.*).

Although the community gardens provide a means for growers to learn from each other and to help motivate each other, the SPUP felt that individuality and resulting agricultural innovations are stifled because of the perceived need to conform to established production practices. A perception that is compounded by the prescriptive approach of the local organisation. Also, rules within the community gardens, based on social norms, tended to exclude certain members of the community from participating. For example, following a death in the family, a member is not usually allowed to participate in the community garden for a period of one year. Also, physically challenged or older, less able people are not capable of walking the usually long distance to the community garden. Those excluded from the community gardens for whatever reason are then forced to work mostly in isolation in their homestead garden.

The SPUP encouraged these excluded farmers to interact with each other and to form informal groups that could then be assisted by facilitators from the SPUP. Such groups exist in a few of the wards in the Valley and interact within and between each other and with the SPUP. Most groups have a farmer who is well established and active, who assists other farmers with advice, seeds and plants. The role of the SPUP is to facilitate these farmer-to-farmer learning activities, promote an ecological approach to production, empower these farmers with skills to increase their production and assist them with the acquisition of plants, seeds and animals.

Biophysical constraints to crop production

Biophysical constraints to production include low soil fertility, high soil acid saturation values, lack of access to sufficient water, weeds, pests and plant diseases. As a result the agricultural potential of many former homeland areas is relatively low. Within KwaZulu-Natal, a survey of community gardens serviced by both NGOs and Government extension personnel revealed that, in most cases, soil fertility status was the major biophysical constraint to increased productivity (Adey *et al.* 1998).

Within the Valley of a Thousand Hills, the majority of soils sampled are phosphorus deficient.

Livestock production

Livestock ownership is fundamental to all Zulu communities, and animals play a central role in their spiritual life. All celebrations and occasions are marked by the sacrifice of animals, including cattle, goats and chickens. Livestock provide meat, milk and a continual supply of manure. Grazing is conducted on communal lands, usually the steeper, less agriculturally productive land. Although communally owned land is used for grazing, there are presently very few community-based livestock management systems in place, and overgrazing is a common phenomenon.

Winter fodder tends to be a problem as very little grazing is available in the winter months. Cattle commonly feed on maize stover during this time, but maize grown on infertile soil does not always provide adequate nutrients.

Those farmers in the Valley who do not own their own cattle can obtain kraal manure from other farmers. It is not common to pay for the manure, but transport can be problematic when farmers are from different areas. Goats and cattle are kept at the homestead at night and are grazed on communal land during the day. Any manure produced during the day is not available for crop production. Chickens are also kept, usually caged near the homestead. Ducks are becoming popular, as they are easy to maintain and are highly productive. The SPUP has introduced a system by which they will supply farmers with animals, usually chickens, ducks or goats and when the animal has produced offspring, these are then returned to the SPUP as 'payment' for the original animal. This means that farmers who would not usually be able to buy animals can still access or increase their animal production capacity.

Livelihoods and socio-economic constraints to crop production

Socio-economic constraints have been identified as poor access to markets, theft, violence, lack of fencing, inability to purchase inputs due to lack of money, difficulties in transporting produce, and poor health of members of the household.

For most families in the Valley, as in other rural areas, income is usually not from one source, and is derived from a number of activities. Some food is produced on the land and animals are kept. Usually at least one family member works away from home, within the community, within another community or in an urban centre. Up to 48 per cent of rural households in South Africa are dependent on wages, with approximately half of South Africans earning less than ZAR1000 per month. The average expenditure on food in rural households constitutes 23 per cent of total household earnings. In South Africa, 22 per cent of all children are stunted due to malnutrition, the main contributing factor being not enough food in the household, and the subsequent lack of a balanced diet. The macroeconomic policy of South Africa is not changing the socio-economic situation and standards of living of many South Africans continue to deteriorate (Bonti-Ankomah 2001).

Unemployment within South Africa is currently estimated at 40 per cent, and it is a commonly held belief that urban unemployed are moving back to the rural areas. There is also an influx in the rural areas of people too sick to work (often due to AIDS), putting pressure on rural households.

Besides crop production, not much of which is sold, income-generating activities include craft making, beadwork, beer selling and woodwork. Craft making and beadwork are time-consuming and both are a dying art as young women are not interested in making a living from these means.

Few rural people in KwaZulu-Natal make a significant income from agriculture. The financial return is often not worth the effort when set against the risks (Taylor and Cairns 2001). Agriculture is often perceived as the occupation of the poor, and young people have no desire to be involved. In a family farming household, usually only the younger children will assist as the adolescents consider the tasks too menial.

The SPUP are encouraging farmers to produce organic produce for external markets where higher prices are obtainable. Despite the observation by Taylor and Cairns (2001) that the expansion of farming based on traditional crops is unlikely to make a significant contribution to poverty alleviation, there is an increasing trend by more affluent consumers to buy traditional crops in supermarkets. However, the problem lies in ensuring an adequate, continual supply to these outlets. Farmers within the groups are working together to ensure that a variety of vegetables is available at one time and that sufficient farmers are growing vegetables at one time to ensure continuity. Although farmers and SPUP are seeking to tailor the supply of produce to meet demand, factors such as market-availability are not yet fully resolved. Farmers feel that the SPUP should assist them in establishing market linkages, but the SPUP feel that unless the farmers themselves address these factors, little sustainability will result.

A constraint to agricultural and rural livelihoods now having a major impact on the survival and advancement of rural agricultural communities is the advance of the AIDS pandemic. AIDS is devastating the most economically productive citizens, those between the ages of 15 and 49, and in rural areas many of these die in utter poverty and with little care. Most women who die leave their children in the care of family members. Old women already struggling to care for others on their welfare pension money are expected to take care of the orphans (Christine 2000). Also, money that would be available to the household for the purchase of seeds and seedlings or for transporting produce to market has to be used for medicinal needs. Many households deal with additional costs by disposing of assets that are needed in production, such as savings, cattle and tools. Children, especially girls, are taken out of school to help with agricultural tasks, as less labour is available for fieldwork when a family member is sick.

There is often discrimination against HIV-positive people in rural areas where access to information is poor. Most HIV-positive people in rural communities do not admit to their condition, and the family only finds out when person has full-blown AIDS (Kelly 2000). Editors of the *Technology Development Needs of African Smallholder Agriculture* concluded that there is a need to emphasise the need to encourage labour-saving innovations in technology e.g. lighter ploughs, modified hoes and planters, intercropping and animal weeding (Kelly 2000).

AIDS is proving to be one of the biggest challenges development work has ever faced, rural development workers (in particular NGOs) have to go beyond raising awareness of AIDS, to active strategies to support rural communities (Lekalakala and Monare 2000). Localised agricultural production should be encouraged, as this will improve the nutritional status of households and keep the carers home-based, near the sick.

To address the issue of HIV/AIDS, the SPUP is promoting organic farming with the incorporation of immune-system boosting herbs, and food gardens that will help to alleviate the sense of helplessness that many families affected by AIDS face. The SPUP is also working with Traditional Health Practitioners (*Sangomas*) to establish which traditional medicines can be grown by small-scale farmers and used at home. The use of traditional vegetable varieties plays an important role in sustainable livelihoods for people affected by AIDS. Not only are these crops more likely to produce adequate yields but, as the seeds and propagating material are kept after each harvest, the financial outlay for crop production is lessened. Their production is also less labour-intensive. Within the farmer groups in the Valley, the effects of AIDS are obvious; although not openly discussed, they are readily observed. Economically active people are dying; the graves are there to be seen. The number of children in the households has also increased and some farmers are

cultivating smaller areas, as their time is taken up looking after the young children. Farmers are also unable to purchase as much vegetable seed as in previous years. And widows head many households. Due to the decrease in available finance, small-scale, low-external-input agriculture will be one of the few livelihood strategies available to rural families afflicted by AIDS. The greatest challenge to development work, the research community and extension services is to empower farmers to ensure sustainable livelihoods.

5.2 *A Promising Pocket-Full of Taro*

This section describes taro cultivation in KwaZulu-Natal and the novel approach of integrating it with other natural resource-based modes of production. Taro (*Colocasia esculenta*), referred to by the Zulu people as *amadumbe*, is one of the most extensively grown indigenous crops in KwaZulu-Natal. Originating in Asia, it is thought to have spread across tropical and sub-tropical Africa via Egypt, where it was recorded over 2 500 years ago (Plucknett 1976). Although it is uncertain how long it has been in KwaZulu-Natal, its cultivation was well established here on the arrival of European settlers.

Taro is grown primarily for its starchy corms, which have small starch grains that are easily digestible. Young leaves are also used as spinach, which provides a dietary supplement to maize (Shanley 1966). Taro is a sought after food item amongst many Zulu communities, to the extent that alternative cheaper carbohydrate sources such as potatoes are not regarded as substitutes (IPS 1996).

Taro is by no means a predominantly 'subsistence crop'. Much of the taro produced in black rural areas is sold locally, and some farmers also employ local people on a temporary basis to assist in the cultivation, which has a relatively high labour requirement.

The technology encompassed in taro cultivation has developed over countless generations of farming. Taro has a relatively high soil moisture requirement and is grown under dryland conditions only where rainfall is high (i.e. above approximately 1000 mm per annum). Where rainfall is lower than this, as is the case in much of the Province, taro cultivation is restricted to wetland areas, which also tend to have more fertile soils (Kotze 1999). Taro is relatively tolerant of waterlogging and therefore does not require extensive drainage. It is characteristically cultivated in raised beds, about 20-50 m² in area, using hoes. Corms are planted in spring, grown through summer and harvested in winter. Although very widespread, taro cultivation has remained essentially hidden to the major technological regime and very little research or technical guidelines exist for the crop. The technology for taro production is well established locally, and government extension services play an insignificant role in providing technical support (Kotze 1999). Another example of 'hidden' indigenous crops is that of traditional Zulu calabashes. There are a

number of these cucurbits, with each different variety serving a specific function: e.g. beer making, milk souring and ladle making, embedded within traditional Zulu culture).

Although the drainage and cultivation of wetlands was actively promoted by the Department of Agriculture until the early 1980s, it is now discouraged. Wetland cultivation is generally regarded as damaging to the natural (ecological) value of wetlands as well as impacting negatively on catchment water quality. However, taro cultivation practices are generally less disruptive than the commercial cropping practices commonly applied in South Africa for a number of reasons:

- Large-scale drainage is not required.
- Tillage and harvesting is by hand, which results in less disturbance, and hence potential erosion, than mechanical tillage and harvesting.
- Pesticides and artificial fertilisers are not used, reducing the impact on water quality.
- There is a shifting pattern of cultivation, with most individual patches being continuously cultivated for less than four years compared with large-scale cultivation where areas are continuously cultivated.
- The spatial configuration of areas cultivated is generally in the form of small isolated areas, rather than larger consolidated areas, which is more favourable for wetland-dependent wildlife (including the red-chested flufftail *Sarothrura rufa*) (Kotze 1999).

Taro cultivation may, nevertheless, have potentially high impacts on the ecological functioning of wetlands, especially if the cultivated areas have a high erosion risk or are very extensive. Therefore, cultivation needs to be well controlled to account for the environmental requirements of the biophysical system. At the same time, other means of utilising the wetland that result in less disruption of the wetland's ecological functioning need to be promoted as incentives for limiting the extent of taro cultivation in individual wetlands. The most promising alternative is probably the harvesting of wetland plants for craft production. Wetlands in KwaZulu-Natal provide abundant fibrous leaf and stem material valued for weaving, and the Zulu people have a very rich tradition of weaving such materials. Mats woven from wetland plants continue to play a significant role in many events, including weddings, funerals and worship ceremonies.

A promising initiative is currently underway at the Mbongolwane wetland, near Eshowe in northern KwaZulu-Natal, to integrate taro production with the utilisation of wetland plants (particularly the sedge *Cyperus latifolius*) used for weaving crafts. It involves controlling cultivation in erosion-sensitive areas and craft development and marketing to penetrate much broader markets than have traditionally been accessible. . The participation of service providers in such integration

is a novel approach, in KwaZulu-Natal at least, and is being nurtured within the LandCare Programme, which provides a vehicle for promoting the initiative more widely. The adoption of this novel integration in other wetland areas will, however, clearly require an enabling institutional and economic environment. The experience at Mbongolwane shows that many constraints (e.g. poorly understood external markets and a diminishing ability to influence cultivation practices) must first be addressed.

6 Discussion

During apartheid, policies and laws were in place that restricted land ownership and trade by black people, and greatly limited commercialisation amongst black farmers. While there was a supportive extension service for small-scale farmers in the former homelands, this was always afforded a low priority in relation to South Africa's overall agricultural production. With the dismantling of the apartheid regime, expectations for the commercialisation of black small-scale farming were high. Progress has, however, been slow owing to several constraints, namely: (1) dwindling financial and human resources within the National and Provincial Departments of Agriculture; (2) lack of a coherent overall rural development programme; (3) a high level of poverty ('poverty trap'); and (4) slow delivery in the transfer of land.

Support for small-scale farmers is caught between focussing either on emerging commercial farmers, who already have reasonable resources on which to build, or ensuring food security for subsistence farmers with very meagre resources. The current government policy appears to be increasingly favouring emerging farmers, highlighting the importance of NGOs assisting the government (or filling this gap and) in supporting subsistence farmers.

The Valley Trust is one such NGO. They seek to assist subsistence farmers with low-external input, ecologically sustainable agriculture, based on a mixture of traditional and introduced crop types. They work through identifying innovative farmers and facilitating farmer-to-farmer learning. This allows for the transfer of promising technologies throughout the farmer learning-groups within the Valley. By working at the homestead level, the Social Plant Use Programme facilitators are better able to perceive the impacts of non-agricultural activities and constraints on agricultural production. From this they gain an overall perspective of the farming system within which the subsistence farmer operates, and are able to engage in a more integrated fashion.

The disadvantage of this is that far fewer farmers are reached directly than by the prescriptive 'community garden' approach of the Department of Agriculture, where many households cultivate land in one location that

is logistically much easier to service than widely spaced households connected by poor roads.

The national and provincial governments are focussed primarily on high-external-input agriculture with introduced crop types in its support for both subsistence and, especially, emerging farmers. Little interest has been taken in promoting low-external-input sustainable agriculture, which is often the focus of NGO support. The high external input, large-scale model clearly remains the dominant regime within the Department of Agriculture and Environmental Affairs. However, with the increasing importance of concepts such as catchment management, biodiversity conservation and long-term sustainability of agriculture, a growing interest in low external-input, ecological agriculture is taking place through such government initiatives as the LandCare Programme. At Mbongolwane we see a novel approach to maintaining the functional integrity of wetlands, which are important hydrological components in the catchment. This involves harnessing well-established traditional technologies previously viewed as unsophisticated by the dominant technological regime. These technologies are being married with introduced technologies around catchment management and market innovation for craft products.

The two promising pockets described in this article, demonstrate that low-external-input agriculture based strongly on local technologies is economically viable, ecologically sustainable and supportive of local cultures and traditions. However, a romanticised return to entirely traditional crop types and practices is clearly unrealistic. For example, people's cultural preferences for particular foods largely determine what is feasible. While some crop types such as taro are still in high demand, others now have a general low preference. Instead, the objective is to blend promoting traditional crop types and technologies with introduced technologies (e.g. green manuring) and 'modern' technologies (e.g. laboratory-based soil chemical analyses to identify specific fertility constraints requiring remediation). Introduced technologies build on local technologies rather than replacing what already exists.

In KwaZulu-Natal the actors, knowledge systems and technologies in place are extremely heterogeneous. The main actors include:

- Farmers (ranging from extremely poor to wealthy)
- Extensions workers
- Educators (secondary and tertiary institutions)
- Agricultural researchers
- Soil analytical services

These actors have a variety of foci and objectives operating at many different levels, from national level down to household level. The situation is complicated by sometimes competing objectives, notably: commercialisation versus poverty alleviation, maximising agricultural production versus respecting ecological constraints, and maintaining the ecological integrity of natural systems. However, in striving to balance these apparently opposing objectives so as to achieve social, economic and ecological sustainability, as described by Goodland (1995), that novel technologies arise.

Interventions by different actors are unlikely to be effective if they take place in isolation. NGOs such as the Valley Trust play a pivotal role in mediating useful exchanges and synergies, nurturing local technologies that are drawn from traditional technologies, as well as 'modern' technologies to achieve improved modes of local production. Together these show signs of leading to positive changes in the dominant regime.

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9 Zeeuwse Vlegel: a Promising Niche for Sustainable Wheat Production

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Introduction

In 1966 the Dutch milling industry used approximately 40 per cent domestic wheat and 60 per cent 'third country wheat' (wheat from the United States, Canada and Argentina) as ingredients for flour *mélanges* for the preparation of bread and cookies. Since then the composition of the Dutch flour *mélanges* has changed considerably. The percentage of domestic wheat decreased to around 15 per cent, third country wheat almost completely disappeared and EU-wheat (first mainly French, later predominantly German) became the major ingredient (see Figure 1). This development raises, out of curiosity and not out of chauvinistic reasons, a fairly simple question: why is the percentage of domestic wheat used in the Dutch flour mixes so low? Is it because Dutch arable farmers produce insufficient amounts of wheat? Is Dutch baking wheat more expensive than that compared to wheat from other countries? Or, is Dutch wheat of poor baking quality? As Dutch farmers produce more than enough wheat to supply the needs of Dutch bakeries (Wiskerke 1997), and wheat prices do not differ between the Netherlands, France and Germany (*ibid.*), the answer must lie in the baking quality of Dutch wheat.

Table 1 The Dutch milling industry's classification system for baking wheat

Indicator ¹	High quality	Normal quality	Filling quality
Hagberg index	≥ 220 seconds	≥ 220 seconds	≥ 220 seconds
Protein content	≥ 13%	≥ 12%	≥ 11%
Zeleny sedimentation value	≥ 50	≥ 35	≥ 25
Milling efficiency	≥ 72%	≥ 72%	≥ 72%

(Source: Kauderer 1994)

The Dutch milling industry uses several indicators to determine the baking quality of wheat (see Table 1). In this classification system three quality classes for baking wheat can be distinguished: high quality, normal quality and filling quality. A fourth quality class is fodder wheat.

Wheat is classified as fodder wheat if one or more indicators for filling wheat are not met.

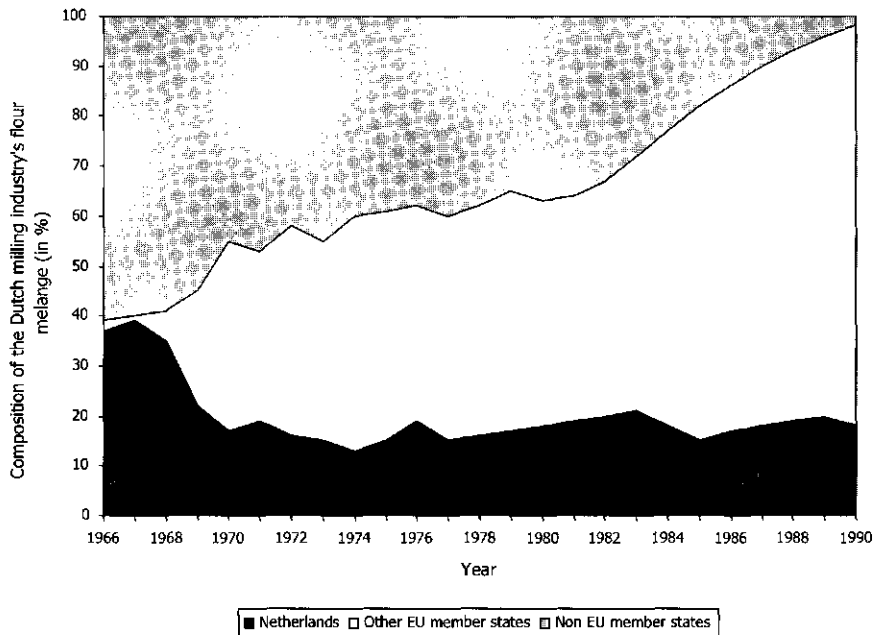


Figure 1 The composition of the flour mélange of the Dutch milling industry according to region of origin in the period 1966-1990 (Source: Kauderer 1993:63)

Quality analyses of the Dutch wheat harvest in 1992 and 1993 demonstrated that, on average, Dutch wheat did not meet the criteria for high quality or normal quality baking wheat. This was due to poor protein quality (expressed through the Zeleny sedimentation value) in both years and a low protein content in 1993 (see Table 2). In addition about half of the 1993 harvest had problems with early germination, expressed by the fact that 49 per cent of the harvest that year had a Hagberg Index of less than 220 seconds. The rather poor baking quality of Dutch wheat in 1992 and 1993 is considered to represent a normal situation, as many wheat experts are of the opinion that one can not produce good baking wheat in the Netherlands (Wiskerke 1995). However, a group of arable farmers in the province of Zeeland, who had organised themselves in an initiative called Zeeuwse Vlegel, succeeded at the same time in producing wheat that only just fell short of the requirements for high quality baking wheat (see Table 2).

Table 2 Results of the baking quality analysis of Dutch wheat and Zeeuwse Vlegel meal

Indicator	Netherlands Harvest 1992	Zeeuwse Vlegel Harvest 1992	Netherlands Harvest 1993	Zeeuwse Vlegel Harvest 1993
Hagberg index (HI)	303 seconds	306 seconds		297 seconds
% of harvest with HI >220s			51%	
Protein content	12.1%	12.9%	11.6%	13.6%
Zeleny sedimentation value	32	49	32	49

Source: Kelfkens 1993; Kelfkens and Angelino 1994; Stichting Zeeuwse Vlegel 1994

The results of the Zeeuwse Vlegel lead us to question the knowledgeability of the wheat experts and raise the question of why one particular opinion about baking wheat cultivation prevails within the 'expert system' (Van der Ploeg 1999). In this chapter we will demonstrate that the prevailing opinion regarding baking wheat cultivation in the Netherlands is embedded in, and the outcome of, a dominant productivist wheat regime. This dominant regime defines the ground rules for wheat breeding, cultivation, processing and marketing. It embodies a coherent complex of scientific knowledge, engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons and ways of defining problems. All of which are embedded in specific institutions and infrastructures (Rip and Kemp 1998). In the following section we will discuss the construction and consolidation of this prevailing wheat regime. We follow this with an in-depth description of the Zeeuwse Vlegel, which we consider to be a promising niche for sustainable baking wheat production as well as an attempt to question and change the foundations of the dominant wheat regime. In the final section of this chapter we will discuss the main barriers and driving forces for sustainable wheat cultivation in the Netherlands. This entails a discussion of both niche dynamics as well as the interactions between the niche and the dominant regime.

Construction, stabilisation and transformation of the Dutch wheat regime

Establishing a closed legal system for commercial plant breeding (1850-1945)

The foundation of the current prevailing wheat regime in the Netherlands can be traced back to developments that started in the middle of the 19th century. It entails the more or less simultaneous development of legal protection of breeders' labour, a binding national list of recommended varieties and a national inspection service. For the sake of transparency we will describe these three aspects separately.

Breeder's rights

The idea of financially rewarding plant breeders dates back to the late 19th century and was initiated by farmers themselves (Sneep 1976). The *Groningse Maatschappij van Landbouw en Nijverheid* (farmers' association of province of Groningen) took the initiative to organise plant breeding

contests (Gielen 1983). This way, plant breeders could obtain an, albeit small, reward for the development of new plant varieties. However, there were no legal restrictions in place at the time to prevent other breeders or farmers reproducing or selling plant varieties that had been bred by others.

Around 1920 the need for the (legal) protection of new plant breeds (and breeder's labour and skills) arose in the Netherlands, due to a set of mutual reinforcing developments and changes:

- An increase in the inter-provincial and international trade of seeds and planting material (Addens 1952);
- The need for higher yielding and other types of varieties as a result of changes in farming practices (mechanisation and the introduction of chemical fertilisers) and a domestic food shortage after World War I (Bouwman 1946; van Zanden 1986);
- The increased 'scientification' of plant breeding practices (Dorst 1957);
- An increase in the number of specialised plant breeders together with the modernisation of plant breeding enterprises.

These mutual reinforcing developments led farmer's associations, agricultural scientists and the Dutch government to the conclusion that they had arrived at a crossroads. If breeders were to continue developing new varieties, they had to be rewarded financially. Failing this, the only other alternative was to set up public plant breeding institutes, based on the premise that new plant varieties are a public good and plant breeding should therefore be financed out of public means (Sneep 1976). From this point onwards a commitment was made to '*rewarding and protecting commercial plant breeding*.' The reluctance of the Dutch government of the time to involve itself (or interfere) with agriculture was one of the key issues that defined how this choice was arrived at. Thus, between 1920 and 1930 a series of measures were taken, mainly by the farmer's associations, to protect and reward plant breeders. However, these measures provided insufficient protection (Wiskerke 1997), giving rise to the need for legal measures. Several existing laws and regulations (e.g. Patent Act, Author's rights) were explored during the 1930's, but these provided inadequate protection to plant breeders. As a result of this, the Dutch Minister of Agriculture appointed a committee in 1940 to prepare specific legislation for breeder's rights. The work of this committee resulted in the *Kwekersbesluit 1941* (Breeder's Decree). According to this breeders could obtain breeder's rights for a plant variety if 1) the variety was sufficiently distinguishable, 2) sufficiently uniform and 3) new. The Breeder's Decree not only regulated breeder's rights but also the role of the List of Varieties and trade in seeds and planting materials. We discuss these two related aspects below.

List of Varieties

The foundations of the List of Varieties can be traced back to the beginning of the 20th Century. At that time field inspections were the main source of information about plant varieties. One of the first attempts to create a list of varieties with accompanying descriptions, to be used as a source of information for the field inspections, was the *Leidraad*: an overview of 50 plant varieties with descriptions (Bouwman 1946). The *Leidraad* was an initiative of the *Zeeuwse Maatschappij van Landbouw* (the farmers association of the province of Zeeland) whose example was soon followed by farmer's associations in other provinces. Together with auction catalogues and field experiment reports these regional lists of varieties with descriptions formed the basis of the Descriptive List of Varieties of Agricultural Crops (hereafter referred to as List of Varieties). The first List of Varieties was published in 1924. Although supported by developments described above, the List of Varieties was predominantly the initiative of Professor C. Broekema, director of the Institute of Plant Breeding (van Marrewijk *et al.* 1991). With the publication of the List of Varieties Professor Broekema aimed to realise two objectives:

- 1 To provide users of seeds and planting materials with a guideline for the choice of varieties;
- 2 To provide recognition of the seeds and planting materials of these varieties.

From its first publication in 1924 the List of Varieties merely served as a guideline for farmers to assist with their choice of plant varieties. The passage of the Breeder's Decree changed the status of the List of Varieties, which took on an obligatory and binding form: only seeds and planting materials of varieties that were on the List of Varieties were admitted for domestic trade. In other words, through legislation the List of Varieties became formalised as an 'obligatory passage point' (Callon 1986: 205). The Variety List Committee (VLC) decides annually on the placement of new varieties on, and removal of existing varieties from, the List of Varieties. The committee's decision is based upon the 'Value for Cultivation and Use' (VCU) tests, conducted under auspices of the Centre for Variety Research². The committee uses two major criteria in the evaluation of submitted new varieties. First, a new variety has to be of demonstrable value to Dutch agriculture. Second, a new variety has to be better than existing varieties. Later on we will discuss how the committee translated these broad criteria into specific criteria for wheat varieties.

Inspection services

The foundations of inspection services for seeds and planting materials can be traced back to seed exhibitions, which were organised for the first time in the Netherlands around 1850 (Sneep 1976). On these exhibitions the quality of seeds and planting materials was assessed on the basis of external characteristics. In 1877 an experimental station was founded,

which also inspected the quality of seeds and planting materials. Several traders of seeds and planting materials were voluntarily supervised by this experimental station. To improve the quality of seeds and planting materials the *Zeeuwse Maatschappij van Landbouw* created a division for field inspections in 1911 (Bouwman 1946). During the same period other regional farmers' associations also established their own inspection services. Due to the growing number of regional inspection services and the increase in the inter-provincial trade of seeds and planting materials the need for national collaboration arose. This resulted in the foundation of the Central Committee for Crop Inspections (CCCI) in 1919 (Addens 1952). One of the tasks of the CCCI was to create inspection regulations, to be implemented by all regional inspection services (Oortwijn Botjes 1957). In 1932 this system of regional inspection services with a co-ordinating committee at national level was replaced by one national inspection service for seeds and planting materials, the *Nederlandse Algemene Keuringsdienst* (NAK). NAK decided to continue the policy of CCCI, which among others implied that only seeds and planting materials of varieties that were on the List of Varieties were eligible for inspection. With the passage of the Breeder's Decree 1941 the inspection of seeds and planting materials by NAK became obligatory: only seeds and planting materials certified by NAK could enter the trade circuit.

An indicator for agricultural modernisation: breeding the 10-ton-wheat-variety (1945-2000)

Taken together the introduction of breeder's rights, the binding List of Varieties and obligatory inspection of seeds and planting materials created a complete and closed system regulating the breeding of, and trade in seeds and planting materials in the Netherlands (Sneep 1976). The Breeder's Decree was subsequently replaced by the Seeds and Planting Materials Act (SPMA) in 1968. This regulated breeder's rights and the trade of seeds and planting materials in a similar way. This new legislation was based on international agreements made at the International Convention for the Protection of New Varieties of Plants (Wiskerke 1997).³ Under this legislation a breeder can obtain breeder's rights if a plant variety meets the criteria of distinguishability, uniformity and stability (DUS criteria) and if the variety is new and has a name (Van Beukering 1992). Despite the fact that have been modified several modifications to the UPOV convention and the SPMA in the intervening period the fundamental basics of the closed legal system, established in 1941 have, remained unchanged.

In order to understand the type of wheat varieties produced by breeders and cultivated by farmers, we need to take a closer look at the role and position of the List of Varieties. It is important to emphasise that the List of Varieties is an obligatory passage point.⁴ Within the range of permitted

seeds and plant materials the VLC categorises varieties to assist farmers with their selections (see Table 3).

Table 3 Overview of the main categories of the List of Varieties

Category	Meaning
A	General recommendation: variety for general use
B	Limited recommendation: variety for special circumstances or for limited use
O	Variety considered to be of limited value or for local use and which, as a rule, is incompletely described or not described at all
N	New, recommended variety
T	Newly admitted variety with sufficient value for cultivation

In the daily practice of wheat breeding and cultivation this categorisation has become an important determinant of the kind of varieties produced by wheat breeders and cultivated by arable farmers. For Dutch wheat breeders the criteria used by the VLC constitute the guiding principle in their breeding programmes:

'Placement of a new variety on the List of Varieties is extremely important to us. Especially if you succeed in breeding an A-variety, you can say that you have had a successful breeding programme. In the promotion of our varieties we specifically use the fact that it has been placed on the List of Varieties. So it's fair to say that we primarily focus our breeding programmes on the admittance criteria for the List of Varieties.'

For arable farmers the List of Varieties is the main source of information for the choice of wheat varieties. Approximately 70 per cent of arable farmers use the List of Varieties as a source of information for their choice of wheat varieties (Wiskerke 1997). When we look at the varieties chosen and cultivated by arable farmers during the past five decades, we find that 75-100% of wheat planted each year is from seeds in category A on the list (*ibid.*) From a quasi-evolutionary point of view, we can conclude that the List of Varieties works as an institutional nexus (Schot 1991, Van Lente 1993). That is, it connects the processes of variation (i.e. breeding of new varieties) and selection (farmer's choice of varieties). According to Schot (1991:85):

'these connections are maintained by certain actors or institutions that are responsible for translating certain (...) requirements into criteria and specifications used in developing technology'.

In this case the VLC is responsible for translating certain requirements into criteria and specifications for wheat breeders. As mentioned earlier, in general these requirements read as 'of demonstrable value to Dutch agriculture' and 'better than existing varieties'. To understand how the VLC translated these general requirements into specific criteria for new wheat varieties we need to examine Dutch and European agricultural

policies in the post War era. The main goals of Dutch agricultural policy at the beginning of this era were:

- A guaranteed supply of food at a low price for consumers;
- Stimulation of the export of agricultural products to improve the national balance of payments.
- A fair income and social life for those working in agriculture.

As early as the early 1950s the second goal of these goals had become the dominant one and gradually started to overrule the third goal (Wiskerke 1997). Increasing productivity, specialisation and bulk production constituted the cornerstones of agricultural policy, science and technological development from the 1950s onwards. Within this 'productivist' paradigm (Roep 2000) wheat quality was conceptualised as 'good raw material for industrial fodder processing' (Wiskerke 1995). The productivist focus of wheat breeders and wheat growers was further enhanced with the creation of the European market and its price policies. This meant that wheat growers could rely being able to sell all their wheat at a given minimum price. The combination of domestic agricultural policy, scientific research and technology development, on the one hand, and the European agricultural policy on the other, led to a situation where the VLC translated the general requirements for accepting new wheat varieties onto the List into one single criterion: a new variety needed to have a higher potential yield than existing varieties. This position was encouraged by the ability of the Dutch milling industry to easily obtain sufficient quantities of good baking wheat from other EU member states. From the point of view of the milling industry there was no immediate need to encourage domestic cultivation of baking wheat. Furthermore, because the Dutch climate is extremely suitable for the cultivation of high yielding fodder wheat varieties the VLC came to the conclusion that within this specific technical-institutional context, high yielding fodder wheat varieties were of 'ample value to Dutch agriculture'. This position and the single-minded focus on yield improvement in wheat breeding and cultivation has remained fairly stable for several decades. In its own somewhat narrow, terms the prevailing wheat regime has been extremely successful. Average wheat yields increased from around 3000 kilograms per hectare in the twenties to 9500 kilograms per hectare by the end of the nineties. Yet as we discuss later, in broader terms it has constrained the development of other approaches to agriculture that emerged as a response to the unforeseen consequences of continual intensification and specialisation.

A summary of the characteristics of the Dutch wheat regime

The aim of this brief historical overview has been to demonstrate how, over a period of several decades, a dominant regime was constructed and stabilised, that subsequently structured and guided wheat breeding and

cultivation practices (see Figure 2). The legal and institutional foundations for this were laid in the first half of the twentieth century. Or, as Sneep (1976) phrased it,

'with breeder's rights, a binding List of Varieties and obligatory inspection – which three aspects were, on top of all, fully aligned – a complete closed legal system for seeds and planting materials was created'.

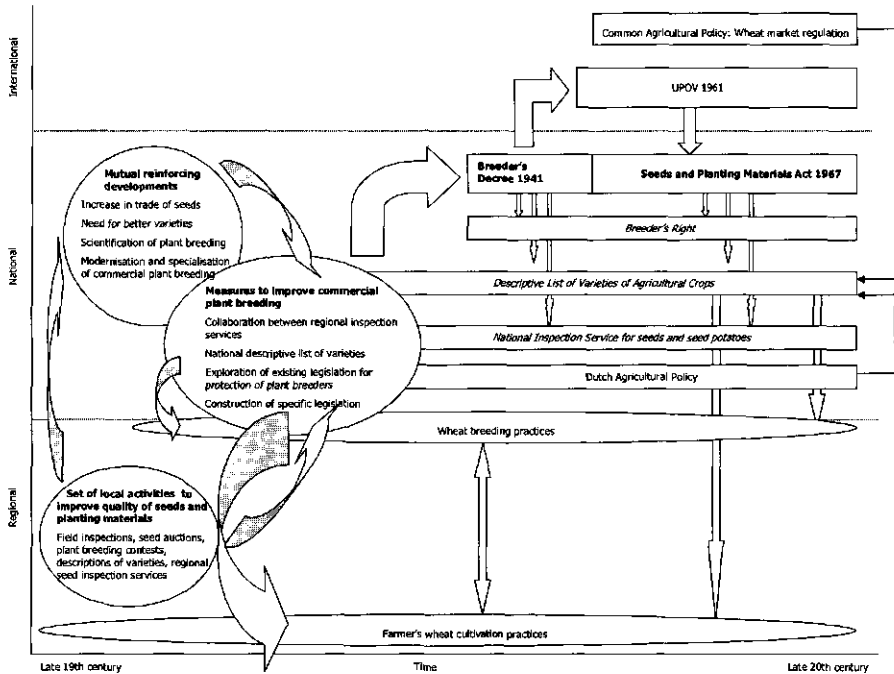


Figure 2 Construction and stabilisation of the Dutch wheat regime

The products of this closed system, i.e. so-called 'improved varieties', quickly became the norm in Dutch agriculture. Farmers who did not use seeds of improved varieties were thought of as being backward (Jongerden and Ruivenkamp 1996) and the so-called 'farmer's varieties' were classified as inferior varieties:

'With the confirmation of the Breeder's Decree the trade in uncertified seeds was prohibited. It also meant that inferior varieties could be eradicated' (de Haan 1949).

After the Second World War the Netherlands became one of the world's largest exporters of seeds (of vegetables and several arable crops) and planting materials (seed potatoes, flower bulbs). In the promotion of Dutch seeds and planting materials breeders and traders regularly refer to the legal regulations as an expression of trustworthiness and reliability. Furthermore, the alignment between breeder's rights, the List of Varieties

and inspection services are seen as the major driving force behind the Dutch' successful international position in the production and sales of seeds and planting materials:

'At the moment the legal protection of breeders is a commonly accepted, if not to say given fact. When the draft of the Seeds and Planting Materials Act was presented to the parliament, no one raised the principle question if and why breeders deserved protection' (van der Kooij 1990). The regulations embedded in the Breeder's Decree and, later on, in the Seeds and Planting Materials Act have, together with the national agricultural policy and the EU wheat market regulation, shaped the wheat regime, which has focused exclusively on productivity. Within the dominant regime issues such as improving the baking quality of wheat varieties remained an irrelevant issue

Attempting to find answers to new societal priorities (1985-2000)

In the late eighties several measures were adopted which can be seen as attempts to move away from the exclusively productivist focus of the dominant wheat regime. One such measure was the introduction of differentiation in the EU intervention price for wheat. The aim of this move was to reduce wheat surpluses by encouraging the cultivation of lower yielding baking wheat varieties. The price differentiation was based upon protein content (one of the factors which contributes to baking quality) of wheat. A protein content of 11 per cent was chosen as the threshold for this differentiation. As most Dutch fodder wheat has a protein content that is higher than this, the measure did not lead to the intended results of reducing wheat surpluses or increasing the cultivation of baking wheat.

A second measure, taken at the national level by the Product Board Cereals and the Dutch Cereal Centre, was the certification of domestic baking wheat. The aim of this regulation was to stimulate the cultivation of baking wheat and the use of domestic baking wheat by the Dutch milling industry. This initiative also failed, because the milling industry was not prepared to pay substantially higher prices for certified domestic baking wheat.

Although both these measures failed, they did encourage a debate about the possibilities for baking wheat cultivation in the Netherlands. This debate was formalised, in 1990, by means of the Quality Day Cereals; an annual meeting of the main stakeholders involved in the production, processing, distribution, sales and quality control of baking wheat and bread. The aim of this annual meeting was to explore ways of improving the quality of domestic baking wheat and of increasing the share of domestic baking wheat in flour mixes of the Dutch milling industry. Another important spin-off from this debate was the decision of the VLC to distinguish between baking and fodder wheat varieties, and to categorise them on this basis (see table 3). In the late nineties the VLC also created the space for acceptance of varieties with a specific value for

organic cultivation or for local initiatives. In 2000 the Zeeuwse Vlegel was the first group of farmers ever to succeed in reinstating a previously displaced variety, namely Sunnan, on the List of Varieties.

The dynamics of niche construction and development

Introduction

The undesirable side effects of the modernisation of wheat cultivation – wheat surpluses, environmental pressure through the use of pesticides and fertiliser and lack of knowledge for cultivating baking wheat, – gave rise to an alternative approach to wheat cultivation in the province of Zeeland⁵: the Zeeuwse Vlegel. The objectives of the Zeeuwse Vlegel were – and still are – the realisation of a sustainable and profitable cultivation of baking wheat and the creation of close contact between producers and consumers. The Zeeuwse Vlegel started in 1990 and has developed into a much-heralded example of sustainable regional quality production, one that is widely cited in national scientific and political debates on sustainable agriculture and rural innovation.

The development of the Zeeuwse Vlegel

Back to the eighties

The foundation of the Zeeuwse Vlegel was laid in the beginning of the 1980s. At that time many arable farmers participated in ‘wheat study clubs’. Farmers visited one another to compare different wheat cultivation practices. They discussed the choice of varieties, use of fertilisers and pesticides and the economic results. But after a few years the differences in cultivation strategies, yields, use of inputs and economic results were explored and understood. The enthusiasm, that was so evident in the early days of the study clubs, slowly disappeared and many study clubs ceased to exist. The few that remained focussed their attention on the production of baking wheat. Through selective choice of varieties and cultivation methods, the participating farmers succeeded in producing baking wheat that met industry specifications. However, the milling industry was barely interested, as it preferred the large, uniform and cheap batches of French and German wheat. The ambitious study clubs did not get what they had hoped for: a reward for quality and craftsmanship. The study clubs in Zeeland demonstrated that the production of good baking wheat was possible, but that the lower yields were not compensated for by higher prices.

During the same period Zeeland’s association of young farmers (Zeeuws Agrarisch Jongeren Kontakt: ZAJK) and Zeeland’s federation of ecology groups and nature conservationists (Zeeuwse Milieu Federatie: ZMF) started a discussion group. Farmers and the ecology groups had often been opponents, but ZAJK and the ZMF had come to realise that

continuous opposition was a dead end street. Instead they wanted to discuss the points of agreement. But, as fine words butter no parsnips, they decided to put the points of agreement into practice. This took some years of thinking, negotiating and organising. At the annual meeting of the ZAJK in December 1988 a project for environmentally sound cultivation of baking wheat was announced. In March 1990 a foundation was launched, which was later named Zeeuwse Vlegel.

Organisational aspects

The farmers participating in the Zeeuwse Vlegel constitute the heart of the Zeeuwse Vlegel foundation. The board of the foundation is chosen every five years and comprises mainly member farmers. The aim of the foundation is

'to assess the feasibility of environmentally friendly agricultural production, to promote this production on conventional farms and to market the produce. Furthermore the corporation aims to close the gap between consumers and farmers' (Stichting Zeeuwse Vlegel 1998).

Besides the board of the foundation there is also a broad counselling committee, in which ZAJK, the ZMF, the farmers' association of Zeeland (ZLTO), organic farmers, wheat study clubs, agro-technical organisations, bakers, millers and consumers' organisations are represented. Initially this counselling committee had a temporary status, but after five year it had proved its value and was made a permanent feature.

In 1994 the board of the foundation decided to establish a co-operative, which now runs the wheat and bread project. The reasoning behind this is explained by the product-manager of the Zeeuwse Vlegel:

'First of all, we want to show the public that the bread project could stand on its own feet and could operate independently from subsidies. Furthermore, we wanted to apply for subsidies to start new projects. This implied that the bread-project and the wheat cultivation had to be disconnected from the foundation. Otherwise it would remain unclear for what purpose subsidies would be used; for new projects or for financial support of the bread. By establishing a co-operative the bread-project is formally separated from the foundation. ... The co-operative and the foundation are financially independent. However, two members of the board of the foundation are also members of the board of the co-operative. Furthermore, the trademark 'Zeeuwse Vlegel' is owned by the foundation. So, if the members of the co-operative decide to use pesticides in the cultivation of wheat, the board of the foundation can decide to deprive the co-operative of the privilege to use the trademark. This way, all participants in the project keep a grip on the bread-project.'

Since its start in 1990, the Zeeuwse Vlegel has established many connections in the province, on national and on international level, resulting in a large network of actors who support the Zeeuwse Vlegel in various ways. The network comprises agricultural research institutes,

government bodies, processing and distribution companies, certification organisations, environmental organisations, financial institutes and education and advisory services.

Scepticism and many questions to answer

The reactions to the Zeeuwse Vlegel approach were very sceptical at first, especially within the world of agriculture. Many farmers and agronomists did not believe in the possibility of cultivating baking wheat of a good quality, let alone without the use of chemical fertiliser and pesticides. This scepticism is reflected by the opinion of a 'wheat expert':

'Not using chemical fertiliser and pesticides will result in poor baking wheat. In fact it will only give you chicken food.'

Many questions were raised by the outside world (farmers, bakers, researchers, etc.) and neither the farmers nor the researchers were able to answer most of them. As one of the farmers clearly expressed:

'The Zeeuwse Vlegel is a completely new way of wheat cultivation. I had to get rid of all the knowledge I had with respect to conventional wheat cultivation and start working and learning from scratch.'

The inability to answer the central question posed by the Zeeuwse Vlegel – How to cultivate wheat in an environmentally friendly way and simultaneously produce high quality baking wheat? – demonstrates the impact of the dominant regime on knowledge production. The wheat regime had produced ample knowledge on how to increase wheat yields through breeding and cultivation, but had produced merely ignorance regarding the environmentally sound production of high quality baking wheat (see also Box 1).

The Zeeuwse Vlegel discussed the problem of weed control with organic farmers. The board and the counselling committee had a long discussion about the use of herbicides.⁶ In the end they decided to permit their use before the wheat sprouted. After this time the use of herbicides, fungicides and insecticides was prohibited. Over the years the farmers have gained necessary experience in this method of weed control.

The next problem the Zeeuwse Vlegel farmers faced was obtaining suitable varieties of wheat. The List of Varieties was of no use. Most of the wheat varieties on that list were high yielding fodder and filling wheat varieties. In addition, the few baking wheat varieties on the List of Varieties were very susceptible to diseases and could therefore not be used in the Zeeuwse Vlegel cultivation method. An extensionist in Zeeuws-Vlaanderen – the part of Zeeland bordering Belgium – was well acquainted with wheat breeding and cultivation in Belgium. He knew that Belgian breeders and farmers had paid more attention to baking wheat compared to the Dutch. The Zeeuwse Vlegel farmers compiled a list of characteristics that they considered be important: baking quality,

disease resistance and straw sturdiness. On basis of this priority list, the extensionist found several wheat varieties.

Box 1 Baking wheat tests as an example of the production of ignorance during the modernisation era.

The 1993 harvest was very good in terms of protein content. The classification system used by the milling industry led everyone to believe that the quality of the flour would be very good and much better than the year before, when the average protein content was lower (see Table 2). The Hagberg index and the Zeleny sedimentation value did not differ significantly. However, the baking test (to determine indicators such as dough quality, bread volume, bread colour, baking nature and bread structure) proved everyone wrong. This led the board to believe that there was something more to the story of baking quality. In 1994 the board of the Zeeuwse Vlegel therefore decided to conduct separate baking tests of several batches. The results of these baking tests are given below and compared with the result of the baking test of the 1993 harvest. It shows that Sunnan has a better overall baking quality than the meal from the 1993 harvest, despite having a lower protein content and Zeleny sedimentation value.

Indicator	Batch ZV218	Batch ZV201	Batch ZV204	Batch ZV215	Harvest 1993
Wheat variety	Sunnan	Renan	Franco	Arcade	Mix of varieties
Hagberg index	327 sec.	359 sec.	359 sec.	318 sec.	297 sec.
Protein content	12.4%	12.6%	11.7%	12.4%	13.6%
Zeleny sedimentation value	42	39	50	42	49
Dough quality	excellent	good	medium	good	good
Bread volume	4200 ml	3900 ml	4100 ml	3800 ml	3600 ml
Colour	8	8	8	8	8
Baking nature	8	7	7	6	6
Structure	8	7.5	6.5	6.5	6.5

That also explains why the overall baking quality of the 1992 harvest was better, despite having a lower protein content. The 1992 harvest contained a higher proportion of Sunnan. This suggested that the variety itself is a determining factor and not just the (proxy) indicators used by the milling industry to classify batches of wheat. The board of the Zeeuwse Vlegel discussed these results with food-technologists, baking wheat experts and scientists. None of them could explain the results of the baking tests. All they could conclude was that there was something more to baking quality than the indicators that were, and still are, used by the milling industry. It leads to the conclusion that protein content is not a universally applicable indicator for grading the quality of baking wheat (see Table 1) at least for some varieties. The same might hold true for the Zeleny sedimentation value.

Besides weed control and selection of baking wheat varieties, the farmers had to find an answer to the problem of manuring: what kind of manure to use, how much, how and when to apply it? These problems had to be solved through a process of trial and error. And even after ten years of

experimenting there are still questions to be answered. After three years the Zeeuwse Vlegel advised the farmers to apply pig-slurry in early spring. From an environmental point of view, spring application is much better than autumn application, the soil temperature is low resulting in a slower mineralisation of nitrogen. Furthermore, it seems to contribute to a better baking quality of the wheat:

'Using the manure in the right way was the biggest puzzle during these years. It was really an 'Eureka' effect when we found out the good way to use manure in spring and to see that the baking quality also improved'

The Zeeuwse Vlegel in practice

The Zeeuwse Vlegel prohibits the use of chemical fertilisers and pesticides. To ensure that farmers comply with these conditions, these aspects of wheat cultivation are inspected by an independent organisation, NAK. More importantly there is an element of 'social inspection'. As soon as the wheat has sprouted, every participating farmer is obliged to place a large sign, stating '*Hier groeit uw Zeeuwse Vlegel*' (Your Zeeuwse Vlegel is growing here), in his field. All the neighbouring farmers know that the use of chemical fertilisers and pesticides is prohibited in a field with this sign and will keep an extra eye on that field to make sure that no chemical fertiliser or pesticide is applied.

After the harvest, every batch of wheat is stored separately. A sample is taken from each batch to determine the baking quality and all those that meet the criteria are mixed. Thus the bakers will be provided with a homogeneous flour *mélange* for the whole year. The wheat is milled in two traditional windmills in Zeeland and the flour is distributed to the bakers in 25kg bags. From one bag of flour 50 loafs of bread can be baked. Fifty wafers are supplied with every bag of flour and the bakers are obliged to place a wafer on every loaf of bread. In this way consumers can be sure that the Zeeuwse Vlegel loaf that they are buying is genuinely made from Zeeuwse Vlegel flour. The board of the Zeeuwse Vlegel determines the size, form, decoration and price of the bread. Because the bread is slightly more expensive than 'ordinary' whole-meal bread (appr. € 0.10) and, more important, because there are very few links in the producer-consumer chain the farmers receive a much higher price for their wheat compared to the EU-price. This is necessary as, although cultivation costs are similar, the yields are much lower compared to conventional wheat cultivation.

Until the middle of 1994 Zeeuws Vlegel bread was only baked and sold by local bakers, underlining the artisanal character of the approach. However, to increase sales the board of the Zeeuwse Vlegel decided to permit the sale of Zeeuws Vlegel bread in supermarkets, provided that they did not undercut the standard recommended price.

Since 1994 several new projects have been started. The first of these, Zeeuws Vlegel beer was launched in November 1994. The beer is brewed

from environmentally friendly cultivated barley, grown according to rules similar to the ones for wheat. In 1996 more new products were launched: wheat meal cookies and a range of meat products (beef, pork and turkey). The meat is produced on farms subject to regulations concerning the environment and animal welfare. Two reasons underlay Zeeuwse Vlegel's decision to start with the producing other ranges. On the one hand the need for broadening the economic basis of the Zeeuwse Vlegel emerged in 1993, as bread sales were not meeting expectations. On the other hand the Zeeuwse Vlegel hoped that the introduction of these new products would have a positive effect on bread sales:

'It is possible that the sales of bread will stabilise or even decrease in the future. In that case it is useful to have a broader range of products. New products contribute to the economic basis of the Zeeuwse Vlegel. And new products will hopefully support the sales of bread. When we introduced the beer we got a lot of publicity. And every article in the newspaper starts with the 'bread story'.'

Sales of both beer and meat failed to live up to expectations. The meat project was abandoned several years after its start and production of Zeeuwse Vlegel beer was discontinued in 2000.

The past few years, the sales of the bread have declined a little, forcing the Zeeuwse Vlegel to search for alternatives. In 1998 several new products were launched which are produced from the Zeeuwse Vlegel wheat such as cookies, and pancake flour. These products can be conserved much longer than bread, and they can be distributed through channels other than the bakeries. In this way, the Zeeuwse Vlegel hopes to broaden its market. For the same reason they joined a new platform of 27 regional producers called '*Van 't Zeeuwse Land*' ('Produce from the Zeeland Countryside'). This platform, established in March 1999, distributes regional products throughout the province. In the remainder of this chapter we will focus on the core activities of the Zeeuwse Vlegel, wheat production and the distribution and sale of bread.

Farmer's strategies

The mainstream wheat cultivation strategy in Zeeland is yield maximisation. This entails the use of high yielding fodder varieties (i.e. varieties recommended by the List of Varieties) and frequent applications of pesticides and chemical fertiliser. Most farmers also don't know where their wheat ends up (Wiskerke 1997: 121-159). Farmers participating in the Zeeuwse Vlegel have chosen an alternative strategy that entails a combination of low inputs (pesticides and fertiliser), lower yields, quality production and higher prices. In addition, the farmers involved collectively control processing, distribution and sales of their wheat.

Farmers participate in the project for different reasons. For those involved in setting up the project a wish to 'turn the tide' was the leading motive. They rejected the passive and defensive attitude of many of the arable

farmers and of the farmers' associations and shared the idea that farmers themselves have to take the bull by the horns if they want something to change:

'Many farmers let others decide what they have to do: they let the seed-supplier choose the varieties, the sales representative of the pesticide-company chooses the pesticides, the extensionist of the farmers' association decides on the crop rotation and the cultivation strategy, etc. Many arable farmers have a very low income or no income at all. Most farmers have become very capable in blaming others for their bad financial situation. I agitate against that because I am of the opinion that you first have to look at yourself before you start to blame others.'

They considered the Zeeuwse Vlegel as a means to regain control and power over their own profession and to cultivate wheat in accordance with demands from society for ecologically sound production. Environmentally friendly wheat cultivation is linked to the production of high quality baking wheat. The higher price of the wheat compensated for the lower yields and is made possible because the members themselves organised the processing and distribution of the wheat.

'My main motivation to become part of this project was that it offered the opportunity to determine the price of our product ourselves.'

In the past decades, direct relationships between producers and consumers diminished as a result of the rationalisation of production and distribution. Wheat cultivation has evolved into producing for an anonymous market. Restoring the link between production and consumption has been another driving force for the early members to participate:

'You know where your wheat ends up and where and how it is milled. You have more insight in the whole chain from producer to consumer. That is very important to me. Most arable farmers have no idea about the destination of their wheat. They transport it to the regional co-operative grain storage, and that's where the story ends for them. They don't know where it ends up and what is done with it.'

The opportunity to experiment with an environmentally friendly way of production was another motivating force for most of the early participants. Because of the increasing dependence on pesticides and the increasing pressure from the government to reduce pesticide use, conventional wheat cultivation was seen as a dead end street. The Zeeuwse Vlegel offered an offensive strategy to tackle these threats:

'Especially in the first years, growing Zeeuwse Vlegel wheat was exciting. I was not sure if I could do it without using pesticides and fertiliser. I've learned a lot, also because we exchanged experiences among ourselves during summer excursions in the field.'

In contrast to the early members, the participants who joined in later were mainly interested in other aspects of the Zeeuwse Vlegel, such as a higher price for their wheat:

'I joined the project because I heard about the substantial higher price they are aiming at.'

Also the challenge of experimenting and cultivating in a way that was generally considered impossible, appealed to many members, both the pioneers and those who joined in later:

'Cultivating wheat in a different way was something I felt attracted to. Getting the hang of something new, taking up that challenge; that appealed to me.'

Another reason mentioned frequently nowadays – not so much for joining, but for continuing to grow the wheat- is that the cultivation method is easy and demands very little labour. It is, however, only labour extensive since a couple of years as the farmers have learned to tackle all problems of the cultivation method:

'Growing the Zeeuwse Vlegel wheat is easy because once I have sown the seeds and spread the manure in springtime, I only have to get on to the field for harvesting. It is nice to see it grow without doing something.'

The impact of the Zeeuwse Vlegel on the farm as a whole varies among the members. The average farm cultivates Zeeuwse Vlegel wheat on four hectares, a relatively small proportion of average farm sizes. However, the cultivation of Zeeuwse Vlegel also offers the members a means to experiment with different techniques and to obtain knowledge that can be used in other crops as well:

'The Zeeuwse Vlegel is a good intermediate between conventional and organic farming. It gave me the opportunity to experiment with environmentally sound cultivation on a part of my farm.'

Most of the farmers, however, see the cultivation of Zeeuwse Vlegel as more or less separate from other crops. The cultivation method and the use of fewer inputs have had no impact on the other parts of the farm. Those farmers describe the Zeeuwse Vlegel mainly as a 'commercial hobby':

'The Zeeuwse Vlegel suits me, I like to provoke a bit by doing things differently compared to my neighbours. Growing wheat for Zeeuwse Vlegel is a hobby for me. The impact on the rest of the farm is minimal.'

Collective strategies

The unique organisation of the Zeeuwse Vlegel, being involved in production, knowledge generation, and the marketing and promotion of sustainable wheat products, offers many opportunities to initiate collective action. The collective strategies of the Zeeuwse Vlegel project take place in the following fields:

- Lobbying, interest promotion, pressure group.

- Developing production methods for sustainable wheat production.
- Distribution and marketing, linking producers and consumers, promotion.

Being active in those three fields implies that the Zeeuwse Vlegel embodies three different types of networks: 1) socio-political, 2) technical, and 3) economic.

Interest promotion and lobbying

The Zeeuwse Vlegel is at first an initiative of arable farmers who wanted to turn the tide by exploring the possibilities of sustainable arable production:

'We started the Zeeuwse Vlegel project because we didn't want to depend on the subsidies from Brussels anymore. As the prices of wheat went down at the same time it was a good time to explore new possibilities. At the same time society started to question the way we produced. They talked about sustainable production, quality production and regional products as being the opportunities for the future. The Vlegel started as an experiment to find out if it really worked.'

By getting organised in the Zeeuwse Vlegel, the farmers became an interlocutor for both regional and national governments on issues on rural development and sustainable production. Being a project they also could get support from the government for initiating the network and promotion of the Zeeuwse Vlegel bread. The regional government embraced this first initiative of regional sustainable production, because it complied with its policy plans. The Zeeuwse Vlegel also contributed to a better image of the arable production in Zeeland and the image of the province as a whole. The national government however, was initially reluctant to support the initiative. In the first year the project could only make a start because the initiators won an environmental prize. The Ministry of Environment was the first to support the project. The Ministry of Agriculture only contributed to the project after they received European subsidies for disadvantaged areas (Objective 5b funds). As the chairman points out:

'Though the government contributed to the project in several ways, it was not always easy to get support. It has been a continuous struggle to convince them of the importance of this project.'

For the Zeeuwse Vlegel, the strategy of producing sustainable wheat and being an interlocutor at the same time has important advantages: instead of spreading only words, they can make their efforts visible because there's a tangible artefact, the bread:

'We took the challenge by starting the Zeeuwse Vlegel. Now we have many years of experience which gives us a position in the debate on sustainable production.'

As an interlocutor for government bodies, the Zeeuwse Vlegel also contributed to the debate on the availability of varieties. Having experienced difficulty in obtaining suitable varieties for their wheat cultivation, the Zeeuwse Vlegel started a lobby to change the regulations concerning the breeding and spreading of varieties:

'The List of Varieties for wheat suitable for the Zeeuwse Vlegel is rather limited because there is not a large market for these varieties and the rules for breeding are very strict. It is therefore very difficult to preserve these varieties. The variety we use the most, Sunnan was bound to disappear because we were not allowed to exchange seeds.'

In 1999 their efforts to become recognised as the legal maintainer of the wheat variety Sunnan were rewarded. The Zeeuwse Vlegel was recognised by the Council for Breeders' rights as the organisation that officially maintains this wheat variety. In addition, the Zeeuwse Vlegel succeeded in replacing Sunnan on the List of Varieties. The farmers are now officially allowed to reproduce and trade seeds of this variety. Organic farmers have shown serious interest in Sunnan. This means that the Zeeuwse Vlegel will not only reproduce seeds of Sunnan for the project itself, but also for other groups of farmers interested in disease-resistant, high quality baking wheat varieties.

The role and experiences of the Zeeuwse Vlegel are often quoted in political debates on genetic resources and regulations concerning the breeding of, and trade in seeds and planting materials. Because conventional research on varieties is often only focussed on productivity aspects, new suitable baking varieties for sustainable production systems are hardly available. Therefore the Zeeuwse Vlegel started, almost right from the start of the project, its own variety research on the regional experimental farm in Zeeland. In 1998, the Zeeuwse Vlegel received a subsidy from the government of Bhutan to support research on sustainable baking varieties of wheat⁷. When he handed over a cheque of USD 100.000,- to the Zeeuwse Vlegel, the Bhutanese minister of agriculture stated that biodiversity is at the very heart of sustainable development. The Zeeuwse Vlegel demonstrated great appreciation for this unusual support:

'For the Zeeuwse Vlegel this subsidy is a welcome gesture and not just from a financial point of view. It again focuses attention to a fundamental problem in sustainable agriculture. On the one hand the government encourages us to work in a more environmentally friendly way, but on the other hand it maintains and legally protects the monopoly of the large commercial breeding companies who only introduce high yielding varieties. We hope that our project, supported by this grant from Bhutan, opens the political debate on the relationship between sustainable agriculture and the constraining regulations with respect to genetic resources.'

The collective strategy of interest promotion and lobby has been successful in the sense that the project is well known and appreciated by many actors in the domain of policy making, politics and society. Not all members think this amount of attention has been of value to the Zeeuwse Vlegel:

'The amount of attention we have got over the years can be dangerous. In many publications our initiative has been set as an example for sustainable agriculture. Sometimes they forget to keep in touch with reality: 70 hectares of wheat is not much compared to the total acreage of wheat in Zeeland and the rest of the Netherlands. The whole story is sometimes blown up, which might also turn against us, because it can be used as a proof that sustainable wheat production is the future for arable farming in the Netherlands. Our chairman once said: the Zeeuwse Vlegel is used as a loincloth.'

Knowledge exchange

The first years, the collective strategy of the members within the project was also focussed on the technical aspects of sustainable wheat production. As a group they could learn from each other and get in touch with research institutes and advisors to obtain the necessary knowledge. By experimenting, exchanging information and obtaining experience from earlier years, they managed to grow the wheat without any major difficulties. In the first years the group of members regularly came together in the summer season to look at the crops and discuss problems and solutions:

'Especially when we started, we spend a lot of time gathering and exchanging the knowledge and experience to grow the wheat in this way.'

After a few years, the need to get together to discuss the growing problems was not there anymore. The enthusiasm to get together and to join excursions became less:

'Compared to the early years in which the exchange of information was also a means to meet each other, there is now less need to see each other. By now, we know how it works, so most farmers don't go the information evenings anymore.'

This lack of occasions to meet each other also affects the feeling of being part of a group. When farmers refer to the Zeeuwse Vlegel corporation, not all of them express being part of a collective initiative. Especially the ones who joined in later talk about 'them' and 'they' when they give examples of what is happening:

'I'm not actively involved in the corporation. Only when they ask me, I sometimes go to a market fair to promote the Zeeuwse Vlegel.'

'I choose the varieties for my fields out of the variety list they give to me.'

One reason for the lack of the feeling of being part of a group is the limited impact of the Zeeuwse Vlegel on the farm as a whole:

'I don't have the feeling of belonging to a group. The interaction is rather limited especially now we have tackled all the technical problems. The Zeeuwse Vlegel is only a tiny part of my farm.'

Other reasons can be found in the lack of market growth and therefore the lack of opportunities to become actively involved in the corporation. Those who have been members from the start talk more in terms of 'we' and 'us' and give examples of collective strategies such as experimenting with new varieties:

'We take care of the availability of the different varieties of wheat. The varieties we use are not of interest to the large commercial breeding companies. The varieties we need have to be resistant to pests and diseases and need to have a good baking quality. Because no research is done incorporating these particular criteria, we do it ourselves.'

Marketing and distribution

Since the start of the Zeeuwse Vlegel much time and effort has been put into the distribution and marketing of the products. As this is a time-consuming activity, the farmers of the Zeeuwse Vlegel employed a 'product manager' to organise the distribution and marketing of bread and (later on) other products. The organisation of distribution and marketing, as a third collective strategy, was thus delegated to one professional employee. Since his appointment, the product manager has also been involved in the other collective activities, but most of his time was dedicated to this third collective strategy.

In the first years the 'marketing and distribution' strategy focussed on increasing the sales of the bread. As it was one of the first initiatives for regional environmental production, it got a lot of attention and publicity. Besides this 'free publicity', the Zeeuwse Vlegel also invested in promotion material. Furthermore member farmers dedicated time to present the Zeeuwse Vlegel at fairs and markets. The signposts in the field, which state 'Your Zeeuwse Vlegel grows here' appeared to be especially effective.

However, the publicity and promotional efforts did not meet the expectations regarding bread sales. In some years, more wheat was produced than could be sold. This was a disappointment for members, several of whom had hoped to expand production. The main reason for poor sales lies in the attitude of consumers who appear uninterested in environmentally friendly bread:

'It is now the time consumers show their commitment to the environment by actually buying the bread. That is what holds us in expanding this project.'

Since the start of the Zeeuwse Vlegel, other regional products, such as beer and bread, have emerged on the markets in Zeeland. Most of these are individual marketing initiatives, in which environmentally aspects

play no role. They do however seriously compete with Zeeuwse Vlegel products, as does the increasing availability of organic products:

'The Zeeuwse Vlegel has a difficulty in distinguishing its products from other regional labels and hall marks. A lot of regional or environmentally friendly products emerged and the difference between these products is often not clear to consumers.'

Assessment of the collective strategies by farmers

When assessing the impact of the Zeeuwse Vlegel the members stress two different aspects. On the one hand they consider the project a success, but on the other hand they perceive several failures. The project is considered to be successful for various reasons. First, they have demonstrated the technical possibility of environmentally friendly wheat cultivation:

'The Zeeuwse Vlegel has shown that we are able to produce in a more environmentally friendly way. That is what I like about this initiative.'

In addition they stress that the Zeeuwse Vlegel shows that farmers are willing to adapt their practices to the demands of society. In this they stuck to their approach and vision, despite the negative response of the conventional farming community in Zeeland:

'They (conventional farmers) see our approach as a personal attack. They believe that we condemn their way of working.'

Furthermore, they have been able to build an extensive network of actors. They have involved researchers, policy makers, marketing experts, bakeries, millers and quality control organisations to support and enable their initiative:

'The Zeeuwse Vlegel shows that a bottom up approach, with an open mind for possible supporters, can be effective.'

This support not only enabled them to produce and market wheat, it also got the Zeeuwse Vlegel involved in political debates on the renewal of the countryside and the debate on genetic resources. Many people set the project as an example of the new opportunities in sustainable agricultural development. This attention and support has been a reward for the energy, time and investments the members have put in this initiative. They also consider their project has improved the image of arable agriculture in Zeeland and generated other regional initiatives. They are proud that they have contributed to this:

'The Zeeuwse Vlegel has been a motor for other initiatives in the region.'

Apart from these successes, several members show disappointment when looking back at the past ten years. The project has not met all the expectations of the members. For instance, in 1992 the members expected it would be possible to produce at least 250 hectares. Now they have had to lower their sights:

'The Zeeuwse Vlegel only covers a small area in Zeeland, 70 hectares. It is a pity.'

Members are disappointed in the lack of consumer interest in Zeeuwse Vlegel bread. Sales remain limited, even after extensive promotion campaigns and new product launches. After working so intensively to develop a sustainable production method in response to societal pressure, they find that this lack of interest leaves a bitter taste. They feel society is letting them down:

'I am disappointed in the consumer. They preach sustainable production, but once they are in the supermarket they choose the cheapest product.'

Also the amount of attention they got, gives them the feeling of being 'cuddled to death'. While facing decreasing sales and lack of possibilities to expand on the one hand and being praised as an exemplar project on the other hand, they get an awkward feeling that something is wrong. Some feel they've let themselves go on the waves of attention and therefore lost their initial focus: cultivating sustainable wheat and distributing it themselves:

'We have been too busy with constructing the building of the Zeeuwse Vlegel and its network. In doing this, we might have lost sight of the purpose of the building.'

Furthermore, the chairman states:

'It is really a lot of work to manage a project like this and to keep things going. Most of the work is done by volunteers and to maintaining continuity is a job on its own.'

Future collective strategies

For the future most members think it is important to reconsider the Zeeuwse Vlegel project. New challenges are needed to maintain members' interest. Some members are even thinking that the project has had its day and is bound to fade away:

'I get the impression that we lack a collective approach to give the Zeeuwse Vlegel a new incentive. Or should we just face the truth and accept that this is it?'

But most members still see a challenge for the Zeeuwse Vlegel, although they find it hard to give clear ideas:

'In terms of acreage the Zeeuwse Vlegel is very small. I think we should focus on something which is really new and innovative instead of holding on to the old formula.'

Individually, they like to continue to cultivate the Zeeuwse Vlegel wheat, but they question if this will remain possible if nothing changes. The Zeeuwse Vlegel is facing difficulties in the sales of its products. Access to subsidies and financial support is decreasing, both because of the competition with emerging initiatives and the attitude of financiers. They think that the Zeeuwse Vlegel has to stand on its own feet after ten years and they perceive the Zeeuwse Vlegel as being less innovative. Some members get the feeling of being entangled in a Catch 22 situation: to take

up new challenges to get more financial backing, they need to have money for new investments, which is presently lacking:

'To strengthen the Zeeuwse Vlegel and to start new activities which give the project a new impulse, we need money and that is something we don't have.'

Most members see new opportunities in expanding the number of products, not necessarily wheat based products:

'Personally, I see a challenge in more products, but the experience thus far with new products is not really satisfying.'

No one seems to really know how to avoid the same kind of disappointments that happened with the introduction of beer and meat. Despite the fact that the present sales do not meet the expectations of the members, some believe that the only possibility for the future of the Zeeuwse Vlegel is to expand sales of their main product. Some think this can be done through intensifying promotion:

'In the future we should focus more on promotion of our products. If we don't succeed in expanding, we won't be able to continue the Zeeuwse Vlegel project for a long time.'

In 2002 the Zeeuwse Vlegel celebrated its tenth anniversary. Inevitably it was a time of reflection and of assessing the organisation, goals and results of the Zeeuwse Vlegel. It is clear that despite the successes and accomplishments of the Zeeuwse Vlegel, there are many questions to be answered and constraints to be tackled. The members of the board think the anniversary presents a good occasion for redefining collective strategies.

The institutional relations of the Zeeuwse Vlegel

An expanding network: network morphology and dynamics

The start of the Zeeuwse Vlegel brought many actors together who used to be opponents or did not have direct relationships with each other. At first the network was built around three pillars: ideology, market and the public sector. Ideology comprises the farmers' organisation (ZLTO, ZAJK), the environmental federation (ZMF) and the consumers association (Consumentenbond). The activities of these groups are mainly those of on interest promotion. These actors came together to initiate the project and to set the aims and objectives of the Zeeuwse Vlegel. The second group of actors, the market parties (millers and bakeries) was involved to concretise ideas and to develop the bread concept. The public sector, especially the Province of Zeeland and the Ministry of Environment contributed to the start of the project and provided the project with several subsidies to facilitate the activities.

Once the Zeeuwse Vlegel had been started, other parties were involved according to the emerging needs of the project. The Zeeuwse Vlegel established links with research centres, the advisory service and quality control organisations. As mentioned before, the network expanded as far

as Bhutan. Presently, the Zeeuwse Vlegel is trying to expand the market for their products by getting involved in another regional initiative, Produce from the Zeeland Countryside.

The collective strategies of the members of the Zeeuwse Vlegel take place in three different fields and incorporate three different, though overlapping, networks:

- 1 Economic: processing, distribution, sales and promotion.
- 2 Technical: research, extension and knowledge exchange.
- 3 Socio-political: interest promotion and policy-making.

In the following section we discuss the involvement of external actors in the Zeeuwse Vlegel and briefly discuss their assessment of the Zeeuwse Vlegel. The role of the regional farming community is included as a part of the socio-political network.

The economic network: processing, distribution, sales and promotion

Two millers and a large number of bakeries (104 in 1997) are involved in transforming the wheat into Zeeuwse Vlegel bread. The millers and bakeries are represented on the counselling committee. Their involvement in the decisions taken by the Zeeuwse Vlegel corporation is organised through regular bakers meetings. During these meetings, the bread concept is discussed.

The millers who grind the wheat, both work with traditional windmills. This type of processing is not feasible anymore for ordinary wheat for economic reasons. Thus the Zeeuwse Vlegel enables the millers to continue their trade, and for the windmills to remain as working buildings. One of the millers regrets the lack of consumer interest for quality production. To him, it is the major constraint for more Zeeuwse Vlegel production:

'I would like to grind more Zeeuwse Vlegel wheat, so I find it a pity that it is so hard to expand the market. I do believe in the Zeeuwse Vlegel because the wheat is of superb quality. It is a pity that bakers and consumers do not always appreciate this quality. We use the whole grain when processing the wheat, while factories often leave the wholesome parts out.'

For bakeries and supermarkets, the Zeeuwse Vlegel bread is one of the many varieties they offer in their stores. Sometimes there are over 50 different types of bread. So the Zeeuwse Vlegel bread does not always get the attention that the corporation would like to see. The participating bakeries and stores sell an average of 5-10 loafs of bread a day and most is bought by a small group of regular customers. The price of the Zeeuwse Vlegel bread is around 15 per cent higher than the price of an average loaf. Bakers do not get an extra percentage compared to the other breads they sell. Bakers' commitment to the initiative varies. Most of the bakers and shopkeepers we informally interviewed (pretending to be customers) have no clear reason for selling the Zeeuwse Vlegel bread. Many did not

know the Zeeuwse Vlegel story and don't link the bread with environmentally friendly production. In one shop which sells the bread we were told the following:

'I don't think we have any environmentally friendly bread, this loaf of bread (the ZV bread) contains more fibres because it is made in a special way.'

However, a few of the bakers/shopkeepers support the Zeeuwse Vlegel bread because they like to have environmentally friendly bread in their assortment:

'Nowadays you just have to have an environmentally friendly product in your assortment.'

Other bakers/shopkeepers like to have regional bread. The Zeeuwse Vlegel sometimes has to compete with other breads with regional names such as Zeeuws Wit and Zeeuws Landbrood.

'I like to sell a regionally product and some of our regular customers specifically ask for it.'

Some bakers think that the rules and regulations, which are set by the Zeeuwse Vlegel corporation, constrain the sales of the bread. It is for instance not allowed to sell the bread at a discount. Some bakers think this is a pity because special offers create consumer awareness, which may later stimulate sales. Furthermore, the Zeeuwse Vlegel corporation determines the ingredients and shape of the bread. Some bakers think this is a pity, because it looks more like ordinary bread than healthy wholemeal bread which is asked for by discerning consumers:

'If they allowed seeds and whole grains in the bread, it would be more appealing and it would look more environmentally friendly. I think more people would buy it'

There is, however, a small group of bakers who participated from the beginning who supported the project throughout the years. They believe in regional production and are proud to sell the Zeeuwse Vlegel bread. They give the bread a prominent place on their shelves. The product manager of the Zeeuwse Vlegel thinks it is a pity that the Zeeuwse Vlegel was not able to stimulate this commitment and enthusiasm amongst other bakers:

'We never got a break through and a general acceptance of our bread by bakers in Zeeland. To me, this is the main reason for stagnating sales.. After ten years, only a few bakers are willing to bake a substantial amount of bread. We were not able to motivate a larger group. Also our decision to sell Zeeuwse Vlegel bread in supermarkets resulted in a refusal of bakers in two large cities to sell the bread.'

Interviews with bakers and employees of supermarkets demonstrate that most of the consumers buy the bread for its taste and healthiness and not for its environmentally friendliness:

'I believe that our customers buy Zeeuwse Vlegel because they like the taste of it and not out of conviction.'

The promotion of the Zeeuwse Vlegel bread has been supported by the ZMF. The ZMF is a regional umbrella organisation for environmental groups. They contribute to sustainable agriculture by supporting innovative farmers, lobbying and advising in regional politics; and putting pressure on farmers who pollute the environment. The Zeeuwse Vlegel initiative fits in their view on sustainable agriculture includes both organic and integrated agriculture. The ZMF is represented on the board of the Zeeuwse Vlegel. Apart from their advisory role, they support the Zeeuwse Vlegel initiative by promoting the products to their members and lobbying for additional funds. A representative of the ZMF acknowledges the marketing problems that the Zeeuwse Vlegel is currently facing and the difficulty in finding solutions:

'The negative experience with Zeeuwse Vlegel meat is probably a constraint for new products. We (ZMF) missed some opportunities with these products. We failed to promote the meat. Promotion is and remains important to market new products.'

According to the representative of the ZMF, one of the reasons for disappointing sales is the producer orientedness of the Zeeuwse Vlegel. The Zeeuwse Vlegel is above all an initiative of farmers, who wanted to produce wheat in a different way. Selling the bread was not on top of the priority list at the beginning, so it might have been taken too much for granted that the bread would be easy to sell.

'A problem is that the Zeeuwse Vlegel is not enough consumer oriented. It is, or at least has become, too much of a producers' initiative. (...) When the Zeeuwse Vlegel wants to survive, it has to enrol consumers, retailers, distributors, supermarkets, etc.'

Furthermore the marketing of products needs professional skills and is time and money consuming. It means keeping up with consumer demands and translating these into bread concepts. For a small organisation, the budget for marketing and promotion is limited. The representative of the ZMF thinks that despite limited funds, a new marketing strategy could provide a solution:

'It's difficult to say whether a new type of bread would increase sales. And won't you lose a group of regular customers with the introduction of a new type of bread? I think it is useful if the Zeeuwse Vlegel were to anticipate the trend of tasty and healthy. Perhaps the best solution is not to replace the current type of Zeeuwse Vlegel bread but to introduce a second type of bread.'

The introduction of new products could be a means for increasing the sale of wheat products. For this, she thinks that organisational changes are needed:

'It remains important to develop new products. To do so, the Zeeuwse Vlegel needs a group of farmers, who are open to new and innovative ideas. The

Zeeuwse Vlegel needs new élan; people who are not hampered by the frustrations from the past and who dare to let go of things.'

However, the chairman of the Zeeuwse Vlegel wonders whether new products, new members and new élan would solve the current problems of decreasing sales:

'I don't think that sustainable production is possible through creating niches in the market, as we did with the Zeeuwse Vlegel. The same counts for other forms of certification. Certification means that the ones who produce sustainably and in a proper way have to make extra efforts to ensure quality and marketing. That means extra costs, while the production costs are also higher than in conventional production. This limits the chances for success. After ten years of Zeeuwse Vlegel, I am convinced that sustainable production is not a neo-liberal issue in which you can trust on the market as structuring principle.'

The technical network: research and extension

The first years, the development and implementation of new types of technologies and production methods was a core activity of the Zeeuwse Vlegel project. Weed control, resistant varieties, the use of manure, baking quality; a lot of questions needed to be answered. For this, the Zeeuwse Vlegel established links with regional research centres to learn about environmentally friendly practices and the production of high quality baking wheat, the advisory service for the most suitable varieties of wheat and quality control organisations for determining the quality of the batches of wheat.

After a few years, several national research institutes were enrolled to provide answers to specific questions. The University of Leiden was contacted for a life cycle analysis (LCA) of the environmental aspects of the Zeeuwse Vlegel, the Centre for Genetic Resources to test suitable varieties, and the Agricultural University of Wageningen to investigate market opportunities and threats. For the selection of good varieties of wheat, the Zeeuwse Vlegel crossed the border and established links with foreign breeding institutes. As mentioned before, the network expanded all the way to Bhutan, from where the Zeeuwse Vlegel received both moral and financial support to continue the research on the utilisation of sustainable wheat varieties. These researchers and other actors involved in the technical network of the Zeeuwse Vlegel have supported the project and its goals throughout.

The socio-political network: interest promotion and policy-making

In 1990, the establishment of the Zeeuwse Vlegel was a tentative initiative. Arable farmers were confronted with decreasing prices for their produce and increasing pressure from environmental policies to reduce pesticide use. The partnership between farmers' organisations and government

bodies crumbled and opposing views and ideas about agricultural development dominated political discussions.

Politicians and policy makers welcomed the Zeeuwse Vlegel project, because it was a living example of sustainable agriculture in practise . It was seen as a model for innovation towards sustainable development in using only manure and no pesticides. The province therefore contributed to the Zeeuwse Vlegel by providing subsidies and by organising promotional activities. According to representative of the province, politicians also used the Zeeuwse Vlegel as a showpiece:

'The Zeeuwse Vlegel project is often used in speeches by members of the Provincial Executive to create a positive image of the arable sector in Zeeland.'

The Province hoped that the Zeeuwse Vlegel would have an effect on the arable sector as a whole. As a representative stressed:

'We hoped that the Zeeuwse Vlegel would be a spin off for sustainable practices in other crops and products. However, this turned out to be too optimistic. The environmental impact of the Zeeuwse Vlegel is limited. Off course, the members grow environmentally friendly wheat, using very strict rules, but the effect on arable agriculture as a whole is limited. It is a pity that the acreage could not grow.'

Farmers see the lack of bread sales as a major constraint for expanding the acreage of the Zeeuwse Vlegel. When discussing this with the representative, he thinks that the Zeeuwse Vlegel might have chosen a difficult market segment, 'ordinary/plain looking' bread. Adjusting the bread concept should be an issue to consider in the future:

'The consumers have a positive image of the Zeeuwse Vlegel, but not many are buying the bread. What I've noticed is that the health aspect is more of interest to the consumer than environmentally friendliness. Maybe the Zeeuwse Vlegel should adjust its bread concept by making it look 'more healthy'.'

There is little doubt that the Province intends playing a less active role in Zeeuwse Vlegel in the future:

'Over the years, the Zeeuwse Vlegel received a lot of financial support from the Province. Now we think it is time the Zeeuwse Vlegel stands on its own feet. The Province is 'subsidy tired' and therefore reluctant to give more financial support. Furthermore, I think the challenge of the Zeeuwse Vlegel lies more in strengthening their own activities instead of trying to get more subsidies. These activities could include: other products, more consumer-oriented products and more investments from farmers themselves in marketing the produce.'

Over the years policy makers have moved from a position of warm support for the Zeeuwse Vlegel initiative to one where they feel that it should stand on its two feet (as indicated above).

The opinions of neighbouring farmers and farmers' organisations have, however, moved in the opposite direction. Initially many local arable farmers were extremely critical about the Zeeuwse Vlegel. A member farmer states:

'Many arable farmers in the neighbourhood are of the opinion that the Zeeuwse Vlegel is a step backwards because our yields are much lower, because we have reintroduced old cultivation techniques, because we have more weeds in our wheat crop compared to them, because we put so much time and effort in promoting and selling the bread and because it is a small scale-project.'

Over the years this attitude changed. The regional farmers' organisation (ZLTO) is currently participating in experiments for sustainable practices in pesticide and fertiliser use. Also neighbouring farmers seem more and more interested in the cultivation aspects of the Zeeuwse Vlegel.

'The Zeeuwse Vlegel creates room for discussion with colleagues. Normally farmers only talk about the yield when you ask them about the result of the wheat harvest. I am glad that they no longer ask me about the yield, because they know the yield of Zeeuwse Vlegel-wheat is much lower compared to conventionally cultivated wheat. Furthermore, they know that the yield of the wheat is of minor importance in our approach. So that implies that they have to talk about other aspects of wheat cultivation and such a discussion is more fruitful to me compared to this useless talking about yields.'

Concluding remarks

Zeeuwse Vlegel: success or failure?

There is no straightforward answer to the question of whether the Zeeuwse Vlegel has been a success or a failure. To tackle this question we have to examine the results of the project in relation to the goals the Zeeuwse Vlegel set for itself and the perceptions of the participants of whether the project is a success or failure. The main goals of the Zeeuwse Vlegel are:

- To examine the feasibility of economically viable and environmentally friendly cultivation methods on conventional farms and to market the produce.
- To implement economically viable and environmentally friendly cultivation methods on conventional farms and to market the produce.
- To reduce the alienation between consumers and farmers.

On all three of these accounts, the Zeeuwse Vlegel can claim to have been a success. In the first place, the Zeeuwse Vlegel has demonstrated that the environmentally friendly cultivation of high quality baking wheat is technically possible, and profitable. Secondly, the participating farmers, together with other actors, have succeeded in organising the processing, distribution and marketing of Zeeuwse Vlegel products themselves.

Finally, the Zeeuwse Vlegel has partially succeeded in bridging the gap between producers and consumers from the point of view of traceability of products. Their bread and other products can be traced from the field to the bakery shops.

The actors involved in the project also refer to a number of other indirect effects of the Zeeuwse Vlegel as indications of its success. These are:

- An increase in Zeeland in the production and sales of regional products;
- More environmental awareness among conventional farmers and farmers' unions;
- More institutional support for similar types of sustainable agricultural development.

Tangible proof of the latter is the recent replacement of the Sunnan wheat variety on the List of Varieties.

Despite a number of successful results, the Zeeuwse Vlegel can also be seen as a failure:

- The sales of bread and other products remain limited and are currently declining;
- Only a limited number of participants is possible;
- A gap still remains between producers and consumers, in the sense that many consumers do not share the philosophy of the Zeeuwse Vlegel. The Zeeuwse Vlegel has also failed to adjust its production regime to meet consumer demands.

Overall perhaps the Zeeuwse Vlegel can be considered a minor success. It met most of its initial objectives and had some spin off benefits. But at the same time it has not yet established a viable market position. It has failed to incorporate all interested farmers. And, if the sales of bread are used as an indicator, it has failed to close the gap between producers and consumers.

Impact on sustainable agriculture

Although it remains difficult to measure the exact impact of the Zeeuwse Vlegel on sustainable agriculture, it is fair to state that the Zeeuwse Vlegel has contributed to sustainable agricultural development at local and national levels. It has actively contributed to the political debate on genetic resources and the legal barriers for sustainable agriculture embodied in the Seeds and Planting Materials Act. As a consequence the Dutch government now recognises these barriers and intends to adjust legislation (albeit within the boundaries of international legislation, treaties and agreements). Furthermore the Committee responsible for the List of Varieties intends to give more attention to varieties or genetic characteristics that contribute to ecological sustainability. The reinstatement of the Sunnan wheat variety on the List of Varieties, is tangible proof of this intention.

Another impact of the Zeeuwse Vlegel on sustainable agriculture is that there is less aversion to spring application of slurry and manure amongst arable farmers in Zeeland. Many conventional farmers are now interested in using spring application methods, not only in cereals but also in other crops. Spring application on a large scale is not yet feasible as the necessary technologies for arable crops are still in the process of development.

Inspired partly by the Zeeuwse Vlegel, the provincial government has switched to a pro-active role in designing the future of arable farming in Zeeland: it now strongly supports the development of regional products and organic farming. The Zeeuwse Vlegel also opened the debate within the regional farmer's unions on other development paths besides intensification, scale-enlargement and bulk production. Many of the representatives of the regional farmer's unions nowadays support the idea that regional quality production and organic farming are economically viable ways of farming. Production and sales of regional products and the on-farm sales of artisanal products have increased in Zeeland in recent years. The Zeeuwse Vlegel, supported by the change in attitude of the provincial government and the farmer's unions towards regional products, has been an impetus to these changes.

The direct and indirect impact of the Zeeuwse Vlegel on sustainable agriculture in Zeeland is mainly of a socio-economic nature. The ecological impact is somewhat limited as a result of the small acreage of the Zeeuwse Vlegel and the fact that for mainly of the farmers involved the Zeeuwse Vlegel has not influenced cultivation methods for other crops. Furthermore, the number of arable farmers that have converted to organic farming, inspired by the experience of the Zeeuwse Vlegel, is very small. Overall, national policy measures (particularly towards manure and pesticides) have contributed more to the ecological sustainability of agriculture in Zeeland than the Zeeuwse Vlegel has.

Driving forces

The Zeeuwse Vlegel had a very successful start in producing environmentally friendly baking wheat and establishing an, albeit small, market niche. This was due to the enthusiasm of all the actors involved – and a firm shared belief in the goals of the project. Enthusiasm was further triggered by the many challenges the participants had to deal with and the many interesting questions had to be answered. In addition, almost all of the early participants felt responsible for the project and realised that collective action was needed to achieve success. These were all important driving forces at the start of the Zeeuwse Vlegel. The enthusiasm, combined with the feeling of responsibility, of a few key actors is still a major driving force at the moment. They dedicate a lot of time and energy to 'keep the Zeeuwse Vlegel going' and seeking new challenges and opportunities. At the same time this has become a major

barrier, as the dynamics of the Zeeuwse Vlegel more or less depends on these key actors.

Another important ingredient for success was the co-evolution of a product (environmentally friendly bread) with a new network of socio-technical relations. During the past ten years the Zeeuwse Vlegel has been supported by policy makers at the provincial and national levels. In the same period the Zeeuwse Vlegel succeeded in enrolling a large number of institutional actors. Institutional embedding and support is a crucial driving force for environmentally friendly farming. At the moment this 'convergent' network of socio-technical relations remains an important driving force. This however only holds true for the socio-political and the technical network. The economic network of the Zeeuwse Vlegel lacks sufficient convergence.

In more general terms one could conclude that new forms of sustainable farming not only demand the creation of new products (including methods, practices, knowledge, etc) but also the societal embedding of these new products. Building and establishing a supportive socio-technical network is thus a prerequisite for new forms of sustainable agriculture.

Barriers

The main barrier facing the Zeeuwse Vlegel is the slow decline in bread sales and the poor sales of other products (especially meat). In the case of bread this is due to the limited commitment of bakers and supermarkets to the goals of the Zeeuwse Vlegel and the limited or even non-existent knowledge about the philosophy behind the approach. Bakers of Zeeuwse Vlegel bread are not really committed to the project because many of them do not actively support the goals of the project and because they don't receive any added value compared to other types of bread. Many of them have no strong reason to promote Zeeuwse Vlegel bread, as it is just one of many types of bread that they sell. According to bakers consumer demand for Zeeuwse Vlegel bread is limited. It is not a distinguishable type of bread (compared to ordinary wholemeal bread) and does not have the image of healthy wholefood. Bakers claim that 'environmentally friendly' doesn't sell bread anymore. As one baker clearly expressed:

'I need to earn money, so that's why I don't give a damn about this environmentally friendly bullshit.'

Given the limited commitment of bakers, who play such a key role in the economic network, it is not entirely surprising to see a decline in commitment and support. In the design phase of the Zeeuwse Vlegel the bakers were actively involved in the design of the project, in particular in the construction of the bread concept. The product that emerged was the outcome of negotiations between farmers, bakers and environmentalists.

However, during the following years the bread concept remained the same, because bakers thought a new concept would not work. Marketing of products not only implies the construction of a coherent network, through alignment of actors in the design phase, but demands continuous effort to maintain alignment and the willingness of key actors (in this case the board of the co-operation) to be open to changes. This is especially relevant in a very dynamic sector like the bread market. Failure to maintain the engagement of bakers, and their ongoing commitment, is one of the evident shortcomings of the project.

A second major barrier, which is more of an 'internal' problem, is that the notion of collectivity has slowly disappeared. The dynamics of the project are centred around two people: the chairman of the board of the foundation and the product-manager. These two, to some extent supported by members of the boards of the foundation and the co-operative and of the counselling committee, feel responsible for the future of the Zeeuwse Vlegel. Most of the participating farmers, let alone other actors involved in the economic network, do not share this feeling of responsibility. They more or less sit back and await suggestions and options from these 'leaders'. This also implies that most participants are reluctant to reflect on the shape, contents and goals of the project or to critically judge new options brought forward by the few more active members. For the future of the Zeeuwse Vlegel it is therefore of crucial importance to revitalise collective responsibility. We have to admit that this is easier said than done.

Another barrier, partly related to the former one, is the lack of new challenges and innovations. In the beginning of the project many questions had to be answered and this triggered enthusiasm and collective action. Collective action took place in several, unexplored fields: marketing and distribution of products, environmentally friendly cultivation methods, selection of suitable wheat varieties and network building. More recently, the challenge of marketing and distribution has been reduced to the question of how to increase sales or, more pressingly, how to maintain the current level of sales. For many participants this issue is the responsibility of the product-manager. The possible range of environmentally friendly cultivation methods has been explored and the most suitable ones have successfully been implemented. The challenge of cultivating has been transformed into optimising both yields and baking quality. Finding and selecting suitable wheat varieties demands continuous attention and research. The quest for better varieties than those currently being used remains challenging, but most farmers see this activity as the responsibility of the board, the product manager and the regional experimental farm. As with distribution and marketing, the

testing of wheat varieties is not perceived as a collective responsibility. Creating institutional support by enrolling relevant actors, and thus by constructing a network, has been a challenging activity from the very start of the Zeeuwse Vlegel. Expanding this network through the enrolment of new actors, especially in the fields of research, utilisation of genetic resources and legislation at the national levels, still is a challenge for some members of the board and is part of the daily work of the product manager. Although the participating farmers support the expansion of the network in this way, most of them do not feel responsible for it.

A fourth barrier that, in fact, comprises all the barriers discussed above, is the fact that all efforts of the actors involved were dedicated to secure the continuation of the Zeeuwse Vlegel in the direction that was set out at the very start of the project. During the last ten years the value of the Zeeuwse Vlegel has never been an issue. As a member of the board stated:

'During the past ten years we have only been working on the building called 'Zeeuwse Vlegel', but forgot to ask ourselves why we built it, why we want to continue working on the building and what the use and value of this building is.'

In group discussions we sensed that, for most members, the structure of the building was so evident that it was unthinkable to transform it, let alone to question its foundations.

Network dynamics

To improve and/or re-direct network dynamics it is of the utmost importance to restore or redefine collective responsibility. For the group network this implies the necessity to define new common interests and challenges. In that respect it may be worthwhile to collectively invest in new options, instead of applying for subsidies, thereby creating common interest and individual responsibility for the collective at the same time. Stricter measures may also help restore collective cohesion, for instance by only allowing farmers who are willing to invest labour, time and/or money in the Zeeuwse Vlegel to participate. This implies that the board of the Zeeuwse Vlegel should reject passive farmers, who only participate for personal gain.

During the later years much of the collective effort has been dedicated to building and maintaining relationships with the outside world. However, a collective strategy should also include the maintenance of relationships between group members. This has been neglected in the last years and thus deserves extra efforts and attention in the near future.

Finally it is important to define clear goals, to monitor progress towards these goals and to undertake action on basis of this. This means that the group has to (re)consider on a regular basis what they want to achieve, how, why and with whom. One of the great challenges the Zeeuwse Vlegel is thus facing is how to incorporate moments of learning and

evaluation in the project. Doing so makes possible to identify whether, and in what ways, collective actions (i.e. networking strategies) are effective.

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Notes

1 The Hagberg index is a measure for the percentage early germination. The Zeleny sedimentation value is a measure for the protein quality.

2 The Centre for Variety Research, The Netherlands (CVN) performs statutory tasks for the Dutch government, including the official testing of varieties for Plant Breeder's Rights (PBR) and the co-ordination of testing for the Value for Cultivation and Use (VCU). The CVN is an independent unit within Plant Research International, one of the research institutes of Wageningen University and Research Centre.

3 Signed in Paris in 1961 this is better known as the UPOV convention (Union pour la Protection des Obtentions Végétales).

4 The binding status of the Dutch List of Varieties lapsed in 1975 with the introduction of the equally obligatory EU List of Varieties. Since then the Dutch List of Varieties is a list of recommended varieties for Dutch Agriculture. In practice farmers mainly choose varieties from this list (Wiskerke 1997).

5 Zeeland is a relatively small province in the southwestern part of the Netherlands, bordering Belgium. Six different regions, mainly former islands, can be distinguished: Schouwen-Duiveland, Tholen, Noord-Beveland, Zuid-Beveland, Walcheren and Zeeuws-Vlaanderen. Approximately 83 per cent of the agricultural land (124.000 ha) is used for arable agriculture, 11 per cent is grassland and 6 per cent is horticulture (both fruits and outdoor vegetables). Tholen, Noord-Beveland and Zeeuws-Vlaanderen are typical arable farming regions, while Walcheren is still known for its relatively large number of traditional mixed farms (arable crops, and livestock). Fruit production is mainly located in Zuid-Beveland. The six regions also differ with respect to the average farm size. Farms are relatively small in Walcheren, Tholen and Zuid-Beveland (especially in the fruit production area) and relatively large in Noord-Beveland and the western part of Zeeuws-Vlaanderen. Small scale farming in Tholen mainly involves the labour intensive production of early table potatoes, vegetables, flowers and seeds (flowers and vegetables). In Walcheren small scale farming usually consists of a combination of arable crops, vegetables, dairy farming and agro-tourism (bed & breakfast, mini-camping, etc.). The large farms in Noord-Beveland and western Zeeuws-Vlaanderen are mainly specialised arable farms, growing crops such as winter wheat, grass seeds, potatoes, sugarbeet and unions.

6 In this discussion the participants not only took the problem of weeds in baking wheat for the Zeeuwse Vlegel into consideration, but also the wider and long term effects of inadequate weed control in baking wheat. In the daily practice of arable agriculture, farmers prefer to control the weeds in cereals, as it is fairly easy in those crops. Control of weeds in crops like potatoes and sugar beet is more difficult and implies a need for more herbicides. So one can choose not to use any herbicides in wheat cultivation, but if that implies that the overall effect is that more herbicides will be used on the farm as a whole, then nothing is gained from an environmental point of view.

7 This subsidy is the result of the treaty on sustainable development between the governments of the Netherlands and Bhutan. This treaty also entails the principle of reciprocity, meaning that the government of Bhutan had to select and financially support a Dutch organisation or project, which corresponds with the Bhutanese view on sustainable development.

10 On Serendipity, Rural Development and Innovations: The Birth of New Cheeses in an Old Mountain Environment in Rural Spain

Gaston G.A. Remmers

Introduction

This paper gives a detailed case description of the development and marketing of new cheeses in a mountainous rural area of Southern Spain (Alpujarra). The case illustrates the *crusade* that rural innovators must embark on in order to succeed, and the qualities they must possess to do so.

The case shows the essentials of the socio-material construction of a local innovation. Local farming practices, local breeds, and local cheese making techniques are aligned with the national financial-fiscal regime and the animal and food sanitary regimes. Yet, the path towards alignment is replete with thorny obstacles. Typically, the global regimes carry an implicit code (script) of large scale, homogeneous and industrial modes of production. The local production and marketing strategies and practices, however, bear the imprints of a small-scale and artisanal type of production. Aligning the two is not easy. The cheese dairy described in this chapter has developed an enormous variety of cheeses. Precisely because of its product innovativeness it is able to constantly supply the market and make a living. Yet, this very virtue is a source of annoyance to the sanitary authorities. The tight integration of the cheese making unit with the olive-farming and livestock systems, enables them to make cheeses with a specific local quality. Yet the financial-fiscal regulations treat these subsystems as separate units, not an integrated whole.

This product innovativeness is a key-issue in the transformation of apparently marginal and odd outlets into solid market destinations, and the transformation of primary products of apparently little value into the basis of local quality cheeses. This process of unexpected transformation from marginal into something valuable is sometimes called *serendipity*. In this paper, I develop the concept in terms of an actor's capacity to perceive at the appropriate moment what is valuable for the success of entrepreneurial rural endeavour and innovation. I argue that this is a crucial capacity in processes of alignment. The case study shows how the cheese dairy entrepreneurs embody this capacity by among other things

oily. It is not a greasy, fatty mess. It is recovered from the region's traditions. People used to conserve their cheeses in this way. In a climate like ours, with these hot summers, how could people keep cheese that would resist this heat when there were no refrigerators? In the old days, all people had their milk, made their cheeses and consumed them fresh; but whatever was left over, they had to transform into something else, throughout the year. And what were the systems for conservation? One was using salt, for the hams – still practised –, another was to smoke it – a habit that has partially been lost in this region – and a third one was to use olive oil. So, a piece of meat, or a cheese, or whatever fresh product, completely covered with olive oil, in such a way that no insects can get to the product, will be conserved in perfect shape. (...) In the 'La Mancha' region, they also conserve cheeses in oil, but not to age the cheese, they put it in olive oil when ripe, only to soften it a bit. (...) We adapted the traditional system of our region a bit, because they used to put several cheeses in one big ceramic jar filled with olive oil that was used more than once... We measure the amount of oil for each cheese, just what it needs, we let it ripen, take out the cheese and let the oil leak out... In this way we save olive oil and maintain a high quality.²

Market alignment and production efficiency

The marketing strategy of the cheese dairy is a logical consequence and extension of its production system. The producers rely on direct sales, through home deliveries, without intermediaries. The flexibility of their production, as well as the personal contact when selling the cheese, is important, because it allows them to make new cheeses on request. At the same time, it allows the sale of 'odd' products, cheeses that came out a bit differently from intended. They can do this because of the shared knowledge and trust that exists between the producer and consumers about the production process:

'We deliberately organise a variety of products, because this is among other things what makes our fame, and have something special. People want something special, products that you can't find in other places, and they have to know that our products are specialities. This means that when I make 20 cheeses, and I sell only 17, I will transform the 3 left-overs into something else, which I can sell later. Our selling system allows us to do so. We visit practically all the houses in the villages. In shops, it is much more difficult to sell... That is logical; a shop should offer a homogeneous product, always the same. ... For example, when I make a cookie with an odd shape, you can't go to the shop and say, 'here are my cookies as usual and this one with a different shape'. ... But if you sell your products to your neighbour, or somebody you know, the odd shape turns into something special, 'look, how funny this cookie...!'... This is what we are trying to exploit, the direct sale. It allows selling almost everything. And adjust the price to the product, according to the softness of the cheese for example.... We never throw away products, it only very rarely happens. There is no need for a fresh cheese that ceases to be a

fresh cheese, to get spoiled, if you have the conditions for production and conservation. And similarly, you explain the consumer how he can conserve his cheese.'

The basis of enterprise flexibility

The cheese dairy has the capacity to carefully re-establish time and again the link between the outcome of the production process and the consumers of these outcomes. The basis of this flexibility is, according to the cheese dairy, the additive free, pure quality of their milk. This they consider fundamental to the success of their cheeses and their capacity for transformation. Elements in the cheese that are not natural such as spores of antibiotics, hormones, other additives, the materials used to cover the cheese, etc. , are considered impediments for the natural transformation of one cheese into another.. Their use would severely restrict the possibilities to make optimal use of their limited production capacity:

'Of course, we are not the same as a big industry that uses, conservatives, colourings, artificial flavours, stabilisers, accelerators, all these chemical products that later on change the taste of the cheese. In the end, these products destabilise, and will then pass on a particular flavour to the cheese ... then there is no way to rescue the cheese. ... However, if you make a cheese based on milk and curd and nothing else, as we do, only natural, pasteurised milk, and curd, without any chemical additive, not even the skin, you will see that our cheeses have an absolutely natural skin, it is only the dry cheese on the outside, we don't use painting, nor paraffin, no anti-mould, no anti-nothing.... So these cheeses are susceptible to change, to transform themselves naturally, without affecting negatively the taste, and without the chemical flavours of industry.'

The concept of serendipity

The transformative capacities of the cheese are equal to the transformative capacities of the entrepreneurs. Jorge and Nuria are able to turn odd into even, and to address a flexible market with highly differentiated, and changing products. They have a capacity to match changes with changes, and see possibilities in odd circumstances. This is their strength. Yet, there is something puzzling about this. From an outsider's perspective, there seems to be an element of unexpectedness in the innovations they are able to make; a kind of fortune that is not sought after, but given. This is the reason why I think that the concept of serendipity may help us understand better the nature of this fortune, and the entrepreneurs' capacity to seize it.

Serendipity is a concept that occasionally enters the vocabulary of scientists, artists and laymen alike, when referring to a discovery of something they had never expected to find. Not for nothing are many second hand bookshops called serendipity; while browsing unintended

through the files, someone may find something that they really wanted. Usually we refer to these situations as accidental or lucky situations, in which fate shows its positive face. In Dutch we speak of *'toeval'*, something which is beyond our control.

The fact that we describe these situations as lucky situations is a question of perception. And this, in my view, is the very essence of serendipity. It shows us that by changing our perception, we are able to find more fortunate things on our way.

Umberto Eco (1999) cites the case of Columbus, 'who – believing he could reach the Indies by sailing westward – actually discovered America, which he had not intended to discover'. Had Columbus settled his mind on finding something within the limits of his idea about the Indies, he might never have valued what he actually did encounter.

Eco discusses serendipity in two layered meanings. First, he asserts it is a 'mechanism' that is at work in situations where ideas, that in the past were conceived of as stupid and foolish, have resulted in discoveries that are part of our dominant thinking and achievements today. Eco claims (p. viii) that

'a number of ideas that today we consider false actually changed the world (sometimes for the better, sometimes for the worse), and that in the best instances, false beliefs and discoveries totally without credibility could then lead to the discovery of something true (or at least something we consider true today).'

In his book, Eco provides numerous examples in the field of language, religion and medieval history of cases in which ideas that we now consider foolish, have led to major discoveries.

Eco then attributes a second aspect or quality to serendipity: stupid, outrageous ideas and efforts in fact have the unintended capacity to show us how well, how adequate in fact our 'normal' world and activities are. He cites the case of Foigny, a monk who intended to create a perfect language, and in doing so showed the world how well the prevailing languages work: for how imperfect they may be, they seem to have something 'extra' compared to the perfect language that makes them serve quite well. He echoes Giddens (1984), who speaks about the unintended consequences of intended action. In fact, Eco says that 'lunacy' or 'lunatic' behaviour or activities, show us how sane we are. This goes beyond the meaning of the popular saying that the exception confirms the rule. It is also more than a paradox; this is an instance where serendipity 'takes place'. By rejecting or ignoring 'lunacy', we will never find out how sane we are. If we reject lunacy, if we reject the odd, we act out of fear; if we accept it, we act out of (com)passion, a desire for discovery and union, and that is when serendipitous discoveries can happen.

Following Eco's line of thought, we can also claim that what we now conceive of as stupid, foolish ideas, bad practice, or an outdated technique, were not always seen as such in the past. In many moments in history several valid options for future technological development have co-existed, and only one (or a few) has prospered. This is often not so much because these solutions were intrinsically better, but because of the networks, resources and power that the people involved could generate or had access to (see e.g. the well known example of the VHS video system versus Video 2000, Cusumano *et al.* 1992). This can also be applied to biological evolution. Gould (1987) asserts that the panda's thumb is a cumulus of ineffective evolutionary steps, some of which helped him survive at the time, but that in fact have given him a sub-optimal thumb. The conjunction of social networks with material ones, in order to generate a 'working' innovation, is an issue that has been discussed by a number of authors, giving the outcome different names: socio-technical configurations (see a.o. Moors *et al.* this book; Callon and Law 1995), or joint performance (Remmers 1998; 1999). Psycho-social studies on some of the worlds acclaimed geniuses (Einstein, Picasso and the like) reveal that *authorship* of an innovative idea is nothing without a successful *process of authorisation* within relevant social, economic and political networks (Schaffer 1994; Gardner 1994).

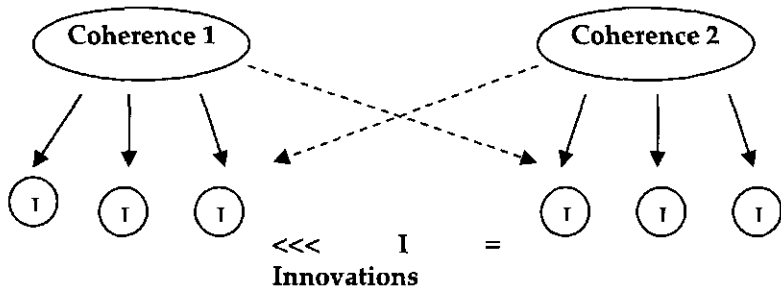
My aim in the remainder of this chapter is twofold. I wish to explore a third meaning of serendipity and I would like to translate the serendipitous process into the field of rural and agricultural innovations. My stance is that serendipity is by no means something beyond our control, but rather a *faculty of an actor*, one that an actor can develop. The American Heritage Dictionary of English (2000) clearly supports this idea, as is shown by the three meanings it attributes to *serendipity*:

- 1 the faculty of making fortunate discoveries by accident
- 2 the fact or occurrence of such discoveries
- 3 an instance of making such a discovery.

At the same time, however, serendipity in my view is not a thing one possesses, nor a thing that generates control over situations; it is, paradoxically, a faculty that provides control and trust in uncontrolled, uncertain, situations. It is a faculty that some football experts call the capacity to 'force fate': a good team, in a tense and apparently equal match, seems able to force a decisive goal at the very last moment. Luck, then, is the outcome of the specific coherence of the team's resources. With this coherence, luck is no longer a matter of providence, as if an external force is mediating, but a possibility that opens up as a consequence of internal logic. Perceiving this possibility, recognising it and seizing it is serendipity.

Applied to the field of agricultural and rural development, this means that, within a certain type of coherence, a certain type of organising the agricultural production, certain innovations may occur, and in other agricultural and rural coherences, others will occur (see Figure 1). The point is that alternative, even deviant, types of innovations are stifled the present organisation of agricultural and rural development,. If the dominant organisation does not allow the spaces (room for manoeuvre) for odd activities, then the process of rural and agricultural renewal will be stifled. *System innovations* will be prevented from developing (Dammers *et al.* 2000). The possibility of interesting discoveries will be limited (as there are few sources or *authors* of innovations), and the *process of authorisation* means that the few discoveries is that are made find it difficult to flourish. (For a discussion on authorship and processes of authorisation, see Remmers 1998; 1999)

Figure 1 A specific coherence gives rise to a certain type of innovations
 (———▶ : innovation occurs; - - - -▶ innovation does not occur)



The case of the *Quesería Morisca* dairy illustrates how specific coherence leads to specific innovations and opportunities. It is the specific organisation of labour, the integration between the component production subsystems, the material resources involved, the knowledge and vision of the entrepreneurs and the market, that enable the cheeses to be ‘born’ as they are, and to make optimal use of apparently wasted resources. In order to do so, the entrepreneurs continuously ‘discover’ things or opportunities. They have, so to say, a faculty for serendipity. Whatever they encounter on their way is converted into something useful. In other words, the apparent inefficiency of their enterprise paradoxically leads to a very efficient production–consumption cycle, where few resources are left unused or spoilt on the way. Following this observation I argue that promoting the occurrence of ‘more’ would be extremely useful way to support sustainable development. Unfortunately, paradise is not just around the corner. Serendipity does not grease the wheels of the *Quesería Morisca*’s interactions with the legal, sanitary and fiscal regimes. The alignments between the two are problematic, as experience shows.

Failing alignment: legal, sanitary and fiscal matters

The process of legalisation of the *Quesería Morisca* necessitated acquiring licenses from five different administrative areas: Tax, Labour, Sanitary Control, Agriculture and Traffic; on top of that several municipal licenses were needed, some of which contained incomprehensible conditions³. Here, we highlight some of the most salient obstacles that were encountered.

Legal and sanitary matters

The diversity of products, and the processes used to generate them, are a major source of sanitary conflict and confusion. The reason is that some of these cheese-making processes are not formally recognised:

'So, what happens? We are involved in recovering local traditions, we communicate with the Authorities about our efforts, to legalise our way of doing things – because we don't want to dedicate ourselves to an illegal activity. And this is where the clash starts. Because the Authorities, that means, the norms and the rules, hardly consider the things that used to exist. In fact, they cannot consider them, because they don't exist anymore... We want to recover these things, and they don't know where to fit you in.... And this is where you find yourself outside of any domain. We are not illegal, because we have our fiscal registration number, everything that we need to function as an enterprise. But as we are making products that are not within the norms, the Spanish norms, the European norms, whatever norms... These norms say 'Cheeses. Fresh cheese, aged cheese, cheese whatever.' But there is no norm saying 'cheeses aged in olive oil'... Well, that is what we make.'

As a consequence, ...

'... we have to convince the sanitary officials time and again that our procedures are sanitary acceptable, that this is not a pig stable, there is no contamination, there is no high bacterial count, that we deliver a safe product in terms of sanitary conditions and that our only 'sin' is that it is not within the norms.... We simply make a different thing. If I arrive in the region and I want to make an Emmenthal cheese, for example, the answer of the technicians is 'ah, Emmenthal, no problem'. Emmenthal cheese has nothing to do with the region, the Alpujarra. But the sanitary officials won't disturb me, because everybody knows what Emmenthal is, and it is described in the norms.'

Formally and legally, some of the local cheeses don't exist and, as a consequence, neither do the sanitary norms to control their production. In other words, *the revitalisation of the local cultural heritage, as well as the transformation of 'anomalous findings' in 'discoveries', in short, the production of alternatives, is legally problematic.* This is so, even when these findings are a materialisation of the singular identity of the region, and rightfully fit in what several authors and policies (including Spanish) classify as endogenous development (van der Ploeg and Long 1994; Remmers 1998).

Formally the local sanitary service could have closed the cheese dairy, but in the end, after long and tedious explications by the producers, the sanitary officers have demonstrated some flexibility and understanding. This example shows that the technical field inspectors are the true obligatory points of passage (Callon and Law 1989), judges who decide on what economic activity can, and what cannot, be accepted. They embody the link between the local and the global; they assume a role that was, in former times, represented by the *caciques*⁴. Where norms are not available regulating the behaviour of these field inspectors, the future of marginal regions as the Alpujarra depend considerably on their empathetic and flexible understanding of the meaning of artisanal production and endogenous rural development.

Yet, there is a sound rationality behind the legal and sanitary norms. They are designed to control production, maintain transparency of origin and composition for the benefit of the consumer, and to guarantee food safety for the general public. Administration takes on the responsibility to guarantee a certain quality, so consumers do not need to bother with this. The norms are there to generate trust. Yet, as we have seen the *Quesería Morisca* dairy generates trust in a different way.

Fiscal matters

In the *Quesería Morisca* dairy livestock production, cheese-making and the marketing system are intimately related, and are managed as inalienable parts of the same business. However, this integration does not fit with the framework of the fiscal system, which generates another series of problems for the dairy. In the first place, the production of agrarian raw materials and the transformation of these materials into a final product, are considered separate activities, subject to different fiscal regulations hence, double accountancy systems need to be used

This fiscal treatment is relatively simply for agricultural production (in their case, livestock and olive oil trees); it is more complex for the cheese dairy. The system requires that the cheese dairy formally buys milk from the livestock farm (the same is true of the olive oil), generating an internal, and seemingly unnecessary, facturation. It also implies that the costs of livestock production (purchase of animals, of a car equipped to transport milk, of fodder, purchase and maintenance of milking system etc...), for producing the cheese cannot be offset against profits from the sale of cheese. The result would be an extraordinary tax. That is why the producers chose to opt for a third, alternative fiscal treatment. This third way, called *estimación directa*, allows almost all costs and benefits to be calculated together. Yet, a serious drawback is that the required accountancy system is extremely complex and time consuming.

Thus, artisanal, integrated cheese production is caught between different fiscal treatments that are not appropriate for the situation. To complicate things further the cheese dairy needs another type of license, that of a

'street merchant' (*vendedor ambulante*) in order to sell products on the street, or even to distribute the cheeses to the households. In short, the Spanish fiscal system does not leave room for manoeuvre for 'livestock-cheese dairies' or 'cheesy-livestock farms'⁵. It may be appropriate for industrialised, compartmentalised industries, but not for small, integrated units, that derive their strength specifically from the symbiosis of their component activities.

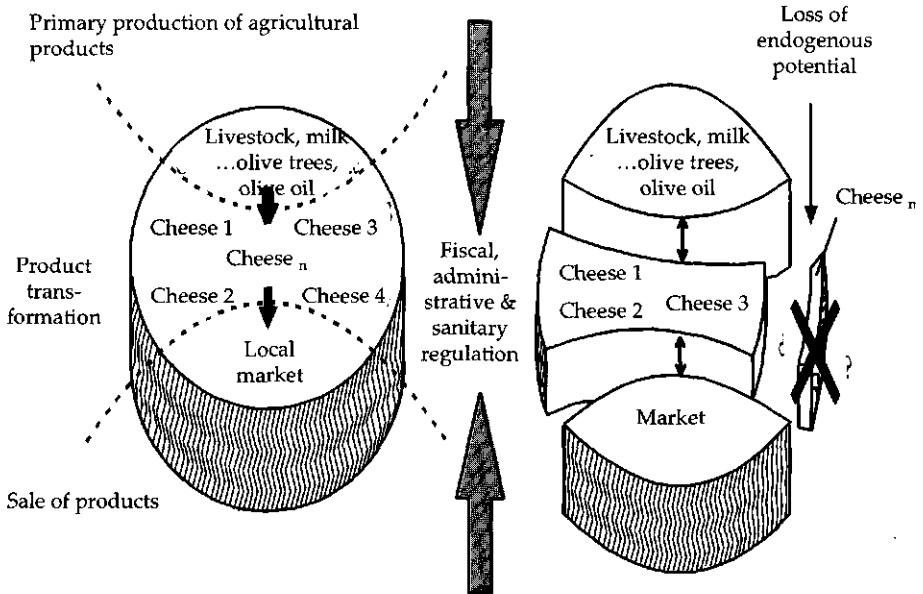
In short, alignment with dominant legal, sanitary and fiscal organisation is problematic, and stressful. Under this pressure, the cheese dairy is being fragmented. It is 'squeezed' like an orange, without any recipient to collect the juice.

The background to the fiscal rationality and the legal and sanitary rationality has hitherto been researched on a mostly general, macro level and, only to a much lesser extent, on a micro level. Critics of this rationality usually view it as an expression of general capitalist development in Spain. Crucial elements in this development process are centralism, sectoralism, control and anarchy. It goes beyond the scope of this paper to go further into detail (for more information about these elements, see e.g. Ortí Benlloch 1997; Sevilla Guzmán 1979; Abad and Naredo 1997).

The complexity of peasant pluri-activity is enormous, especially when contrasted with bureaucratic simplicity: a rural entrepreneur is a jack (but also master) of all trades: producer, transformer of products, and sales person. And has to be all, in order to survive. Administrative compartmentalisation breaks up and strangles this flexibility, which is its essence. In this respect one can see that pluri-activity, much supported by most current European rural policies, is being stifled. The ever-increasing legal pressure cracks peasant activity, even provoking the loss of some branches of pluri-activity. This is illustrated by another household in the Alpujarra area, that ripen hams, as one of its economic activities, alongside wine-making, almonds and fig growing;

'We have been ripening hams for many years... We were informed about what we should do to have everything in order with the law. ... Well, we need to comply with such exaggerated prerequisites, a reception hall, a freezing hall etc.... These are investments that are more costly than what we have earned with the hams in 10 years! We don't even think about it. We keep it as we have it now; if they oblige us to make changes, we will simply close the business.'

Figure 2 The fragmentation of artisanal cheese production and the loss of endogenous development potential due to fiscal, sanitary and legal prescriptions.



(The example of cheese)

Barberis (1992:28-29) uses the term 'sanitary terrorism', referring to the hygienic requirements that are apt for industry, but out-of-place for artisanal production⁶.

An issue that makes the alignment problems all the more problematic is that the legal, fiscal and sanitary regulations apply from the very beginning of the activity, when the dairy has the least means to comply with them. Their enterprise is constructed gradually:

'We need a minimum volume of activity.... But our stock of cattle is not made over night. We started with 60 goats. After the summer we bought more, then we had some drawbacks, cattle diseases etc. Logically, this is a living, biological process. So we have to construct our stock, our enterprise little by little. ... Yet, we are required to comply with all the norms from the very start. And this is not possible all the time. ... And at the same time you, we need to generate some income, so we have to start to sell the product....'

This makes it evident that different alternative innovations, that are born from within a region, that use local, high quality resources but have a low throughput need 'protected spaces' in which to grow.

Transaction costs, processes of authorisation, artisanal production and rural development

So, what happens? The *Quesería Morisca* is an example of entrepreneurial, innovative activity that bears all the potential of endogenous rural development. The producers are authors of innovation, valuable social carriers for rural development. Yet, it is very hard to get the value of their innovations across. The process of authorisation of their innovation is troublesome; transaction costs are very high. They are quite vulnerable, and amidst an alien organisational structure. The specific coherence of their production and consequently, their innovations do not match easily with the dominant organisation of production, transformation and marketing. Support is lacking. Hence, the need to construct a new type of organisation, that suits their specific way of production. The *Quesería Morisca* defines its situation as follows:

'We wanted to recover a product that had disappeared from the region. We wanted to adapt this product to the current legislation, even when this legislation does not consider artisanal production, not even small enterprises. And to face the market, we have to compete with all the others. ... We would expect some support for this from the Administration, but there is none. (...) We are trying to put up an association of artisanal cheese makers that develops a hallmark, a label, that identifies a truly artisanal cheese from one that is not. We need this, because at present the word artisanal is added to almost everything, a kind of Jack-of-all-trades. This is false competition, it is a cheat. Here is where the Administration could involve itself here, but it does not.'

The EU-LEADER programme would seem to be the perfect supporting programme for this type of rural innovation. And indeed, The Alpujarra LEADER 1 programme was favourable towards the development of the *Quesería Morisca*, and has granted a substantial subsidy, which arrived quickly and on flexible terms. Yet, in overcoming the assorted transaction difficulties, the LEADER programme appeared not to be helpful:

'We have consulted them occasionally, and have given a little help, but they have not been able to really break the ice. They support the idea morally, and show understanding of our situation, but that is it. (...) The point is that they only deal with what is legal.... The problem of LEADER (in the Alpujarra region, GR) is that it has nothing prepared for artisans, or even for small enterprises in general. LEADER moves within the limits of legality. Maybe it is logical that they do so, but it does not help our kind of innovations.'

What then, are the characteristics of the artisanal type of organising production? What are the core elements of the artisanal coherence? According to the '*Quesería Morisca*' there are four key characteristics. First, the 'small dimension' of its activity (sometimes even related to the seasons of the year). Second, production based on primary materials generated for the most part by the artisans themselves (the cheese makers

say that an artisan 'auto-consumes' his own production). Third a non-standard output, as the production is carried out in conditions that can not always be the same nor can be controlled, which makes every product unique. Finally, a distribution system that is run by the producer himself, 'because only he knows what he is selling, how it was made and what the result is'. These things imply a small labour force, limited in practice to the family.

The added value of artisanal activity consists in the mutual reinforcement of different parts, creating strong interdependencies and synergy. This results in a complex performance that in turn demands an agile administration, manoeuvring with the communicative qualities of a shoal of dolphins. The current administrative procedures and requirements, adapted for bigger enterprises, are, to say the least, too rigid and too slow. The weight of these separate transactions is too great. Those who, without support, are able to carry on their 'deviant' activity and can make the authorities understand its essence, must possess many specific qualities: perseverance, trust in ones own capacity, conviction of the right to 'a place under the sun', perspective on the future, a strategy to counterbalance risks, a capacity to challenge and at the same time to establish dialogue, to name but a few. A local saying from the Alpujarra area summarises these virtues: to successfully see the transaction processes through, one needs 'balls and mastery' (*cojones y maestría*: see Remmers 1998). In this case, the 'balls' refer to the courage to conquer a niche within the official, legal boundaries. The 'mastery' refers to the knowledge of the ways of bureaucracy and the technical and organisation aspects of a complex production process that generates a highly diverse quality production. These are the two crucial factors that enable their survival.

It is not only in Southern Spain that rural innovators need to possess almost superhuman capacities. The same is true in a country like the Netherlands. Since the mid-seventies, several groups of farmers have been struggling to develop alternatives to the dominant intensive production system; many civil associations in small villages have been involved in drawing attention to unsolved local problems and alternative solutions in areas as diverse as traffic, the safety of school children, housing, green areas etc... Most of these groups, especially the farmer-based groups, have had to struggle on the margin for years. Only in the mid-nineties, after a change from a rural policy oriented purely towards agricultural productivity, towards one with a greater emphasis on the multi-functionality of rural areas, have they gained more respect.. Suddenly, their efforts were recognised as highly relevant. And the few examples that did not die were warmly embraced. Is this serendipity? The point I wish to make is that changing a policy, changing a perspective,

generates a potential that was not previously recognised. In The Netherlands, it has led to an impressive number of civil society contributions to socio-economic, environmental and spatial development of the rural areas (with over 1000 rural groups in the Eastern-Northern part of the country alone). There are a lot of alternative, innovative proposals for rural and agrarian development that are 'rooted-in-practice'. Some of them may be true 'eggs of Columbus', literally encounters with a new, and at the same time self-evident world. Developing the institutional capacity to hatch these 'eggs', in other words, to generate the conditions in which serendipitous discoveries can take place, is a true challenge. Appropriate support and alignment mechanisms for these 'eggs', these local groups and rural innovators, adapted to their specific logic of operation and dynamics, are badly needed in Spain, in the Netherlands (Remmers *et al.* 2000) and everywhere else. Without such hatcheries to nurture innovations, one just gets more of the same, as was made clear by Jorge and Nuria of the '*Quesería Morisca*':

'Look, if you want to start a bar, it is much easier to get support from the municipality, because there are lots of them. But if you want to establish a cheese dairy, where there was none in this village, they don't know anything. You always have to move first, and try to foresee what type of objections they will raise, foresee the troubles that will come your way, in order to try to get around them from the very start.'

Concluding remarks

Back to serendipity. There is a fundamental difference between artisanal and industrial production regimes. Artisanal production is rooted in the transformation of anomalies into success stories and trustworthiness, of what was not sought for into something that is very much appreciated and useful. By contrast, , industrial production departs from what it wants to discover and so only what it looks for. In artisanal production, innovation is embedded in the production and marketing process. In industry, innovation is usually separated from production and marketing, in research units, in which scientific procedures predominate, and often limit perspectives and views. Serendipity may 'happen', once in a while, yet in artisanal production, this is a continuous process. The '*Quesería Morisca*' shows that innovation starts where anomalous situations are allowed to exist, to come into being. Table 1 sets out a range of anomalous situations, and their serendipitous counterparts as a basis for understanding the transformative potential of serendipity.

Table 1 Glossary of indicative terms for innovation processes in artisanal conditions

<i>Anomaly</i>		<i>Discovery</i>
Tension	transformed into	Coherence
Accidents	transformed into	Fortune
Odds	transformed into	Even
What is not sought for	transformed into	What is very much appreciated
False	Transformed into	Fast
False	transformed into	Truth
Lunacy	transformed into	Lucidity
Useless	transformed into	Useful
Inefficiency	transformed into	Efficiency
Weeds	transformed into	Crops
Disease	transformed into	Health
Chaos	transformed into	Order
Redundancy, imperfection	transformed into	Perfection
Sickness	transformed into	Cure
Survival	transformed into	'normal' life

In the example of *Quesería Morisca* the graceful and continuous transformation from anomaly into discovery is a combination of various things. First, it can only take place because the production regime is very much aligned with the local market. However, this alignment is not taken for granted; it is much more the capacity to perceive a possibility of alignment. This is where serendipity comes in. Second, alignment takes place when processes of authorisation succeed. There is a long process of struggle between the moment of the first discovery, through to the phase of upscaling until finally wider recognition and valorisation are made possible. Much research over the past decades explores factors that determine the process of authorisation: financial resources, power, networks, capacities to enrol, class, status, language, etc... My focus in this chapter is on the sheer faculty of seeing virtue in something odd. Following current debates in communication studies, this is also the starting point of learning processes, of processes of re-framing and of paradigm shifts (Groot and Maarleveld 2000; van Woerkum 2000; Cerf *et al.* 2000; Remmers *et al.* 1997). So, I would argue that it is important to dedicate research to establishing how the capacity of seeing virtue in something odd can be enhanced.

In most industrial, global and standardised environments and in most political-administrative environments too, the point of departure is exactly the opposite from the anomaly: control, and, even, predictability. To innovate from the state of anomaly is to research disjunctures and accidents, and to loosen control over known situations. True efficiency, that is, efficiency geared towards the continuity of life (of a nation, a farm,

a firm, an enterprise, a marriage), is the capacity to organise and cherish inefficiency. The pursuit of efficiency is human, as is that of absolute security (Beck 1992). It is at the same time self-defeating. Serendipity 'behaves', so to speak, much like (bio)diversity. It is crucial to our existence; yet, it is difficult to organise or to control. There is little sense in tacking stock of all living organisms, but there is wisdom in creating or ensuring the conditions in which new organisms may evolve and develop, so that life can perpetuate and reproduce itself. Likewise, there is no sense in mapping all imperfections. It is more a matter of appreciating what one perceives as anomalies (imperfection, redundancy, tension, conflict, rituals, agricultural practices, heterogeneity...etc.⁷), being compassionate about them, and valuing them for their potential in shaping possibilities for meaningful worthwhile and unforeseen, consequences of intended action to take place (Giddens 1984). From this stance, a whole new design perspective for rural and agrarian development arises (see Remmers 1999 for an action-theoretical elaboration of this design perspective).

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Notes

1 Ecological grain cost about 80-100 pts/kg (0.48-0.60 €), conventional grain cost 30-40 pts/kg (0.18-0.24 €) (pers. com. J. García Talavera, March 1996).

2 The use of olive oil is certainly a very old technique. Trillo San José (1994:193, 204), in her study of (pre-)medieval sources, cites Alonso de Herrera, christian agronomist, who mentions, the use of oil to accelerate the ripening of figs. Alonso de Herera, as does the arab agronomist Ibn Luyun, specifies, according to Trillo San José, numerous techniques to conserve perishable fruits (cherries, pears, medlars, apricots, with, among others, honey, water and pepper.

3 An example is the evasive manoeuvre they had to undertake in order to acquire permission to use their car as a medium to transport their products. They owned a *big* car, that they intended to adapt in order to properly transport cheese. However, the 'traffic' department didn't give permission, as the car was over 6 years of age. They were forced to buy another car, second-hand, also older than 6 years, but *smaller* in size. For this size no permission was required. Jorge and Nuria ended up adapting this car into an isothermic unit and in this way 'we finally are able to drive legally, and put some advertisements on our car'.

4 *Caciques* were a kind of feudal chiefs, that provided gifts to the national authorities (in the Alpujarra, this ranged from hams to votes in national elections) in exchange for favours for the regions they were the leaders of (e.g. political support, money, a permissive attitude *vis-à-vis* odd local practices).

5 This is not the place to discuss the ins and outs of the Spanish fiscal system. See Remmers (1998:276-8) and Agencia Tributaria (1995a); Real Decreto de 16 de diciembre 1994, n° 2414/1994, published in BOE n° 303 de 20 de diciembre 1994.; la Orden 25.893 de 28 de noviembre de 1995, published in BOE n° 286 de 30 de noviembre 1995.

6 He says, for example: 'The hygienic rules that oblige to dissociate the areas where sale takes place from the working and delivery areas, imply some investments that they (the producers) are not willing to undertake, as their buildings were designed following a different vision on the *internal organization*.' (p. 29, our italics). The term 'sanitary terrorism' (*le terrorisme sanitaire*) was born in an European funded comparative research project of 5 Mediterranean countries, on the valorization of regional quality products and their contribution to the revitalization of local economies. The seriousness of Barberis observation

(Louwaars and Marrewijk 1997:128). They are not registered nor formally marketed and exist only to the extent that they are used in farmers' fields. The seeds are maintained and developed through yearly mass-selection from the previous year's harvest and the local maize is distinctively different from the modern and hybrid varieties that are generated through maize breeding programmes.

The last part narrates what happens when 'modern' maize varieties encounter the breeding and cultivation practices of local people. Through analysis of contemporary patterns of maize production, we hope to answer the critical questions of whether, or not, these two technological regimes interact, and what specific forms this interaction takes in practice. The empirical material for this chapter is based on 3 years of fieldwork in the villages of Nyaminia, Muhanda and Muhoho, situated in the Siaya region of Luoland. The analysis draws on existing ethnographic literature and local people's accounts. Particular emphasis is given to the role that certain elements of the complex system of kinship relations among the Luo of West Kenya play in mediating choices and practices. This also serves to elucidate the complex set of social relations by which the Luo engage in production, distribution and consumption of resources and material goods. Kinship, or more precisely in this case study, the organising principle of seniority, is intrinsically embedded in Luo cultural repertoires. Practices like 'first sowing' (*golo kodhi*) and 'first harvesting' (*dwoko cham*) are based on seniority and, even today, remain important elements that shape agriculture, despite commoditisation, labour migration and the increasing influence of churches.

The elements of the cultural repertoire of the Luo that we analyse here can be understood as a configuration that works in the daily practice of farming, as it does not upset the social fabric of rural life in Luoland. This despite these cultural notions not being universally shared by the Luo. Analytically, we perceive the Luo cultural repertoire as part of a specific socio-technological regime of mass selection and breeding consists of a, more or less coherent, set of rules and conventions that are embedded in local knowledge repertoires, and in a variety of agricultural practices, institutions and networks that include various actors. The hybrid maize-breeding regime must be conceptualised in a similar way (see Moors *et al.* this book). Thus our analysis positions culture as part of a complex set of social relations of production that shape agricultural practices (Hebinck and van der Ploeg 1997).

Culture is often presented as a domain that stifles the optimisation of production, a view that one encounters in the field as well as in the policymaking domains in the so-called Third World. The crucial point we advance in this chapter is that the predominant socio-technical regime of hybrid maize packages misunderstands (or misreads) and therefore bypasses these culturally embedded notions about agriculture and 'how

to farm'. In the end, it is the people that create room for manoeuvre for themselves by maintaining and reproducing a particular cultural repertoire, despite it being sometimes contested and questioned. More interestingly, however, are the ways in which repertoires of local knowledge also question and contest scientific bodies of knowledge. Local people immediately counter claims made by experts (e.g. maize breeders) by referring to their own agricultural practices, such as mass selection. The debate on productivity and selection procedures clearly illustrates this. The processes of creating room for manoeuvre are based on distancing of actor projects rather than on interlocking with the predominant socio-technical regime that is organised by the state and market.

Socio-technical networks and the proliferation of maize in Luoland

The Luo originally planted sorghum and millet grains, but these have been gradually and largely replaced by maize as the major crop grown. Luo agriculture saw major transformations over the years and gradually moved from shifting cultivation to fallow based agriculture and later to a stage of permanent cultivation. During later periods (roughly since the 1940s) agriculture was transformed through the processes of commercialisation and intensification. More recently (from the 1970s onwards) agriculture can be characterised as being in decline, and subsistence production and localised trade predominate. The pursuit of off-farm income opportunities and careers outside agriculture have led to labour migration, which has been accompanied by population growth, a reduction in field sizes and a decline in soil fertility.

For the Luo people the ecology of northern Siaya presented new possibilities compared with the dryer areas from where they migrated. The heavier rainfall during the short rains made possible the gradual development of a second agricultural season from September to November. During the 1890s, in fact, the people of Nyamninia, Muhanda and Muhoho were still experimenting with different crops during the short rains and usually planted sesame, vegetables, or pulses. Later, with the incorporation of new varieties of rapidly maturing maize as a staple food, short rain cultivation became a fully-fledged part of the agricultural cycle.

Although maize was grown in small quantities well before the beginning of the 20th century it only came into prominence with the distribution of improved varieties of white maize during World War I (Heyer 1975:146). By 1930, maize was already well established in Nyanza province. Maize was popular because of its higher yielding potential, compared to indigenous cereals, in areas with satisfactory rainfall and free draining soil. It is seldom seriously damaged by pests or diseases in the field and is virtually untouched by birds, which can cause a complete crop loss in

some of indigenous cereals. Land preparation, weed control and harvesting all required little labour (when done manually) compared with some of the indigenous cereals, and threshing or winnowing and bird scaring is not required. Some people mention that maize is more palatable as an additional advantage, but this appears to be a recent and local adaptation of taste.

Networks

During our fieldwork we tried to trace the origin of the existing local varieties of maize in Siaya. This was done through consulting literature and through ethnographic interviewing of old, knowledgeable people who could still remember the introduction of the different maize varieties to the area and who themselves were active participants in propagating them. These sources of information confirm that maize came through different networks. These are treated and understood here as distinct socio-technical networks, each playing a role in bringing in different maize varieties in the Luolandscape. The networks thus connect Luoland with different sources of genetic material originating in different geographical areas. A second element that differentiates these networks is that different kinds of actors are involved, such as traders, migrants, returning soldiers from the First World War, settlers, plant breeders, and so on. Each had a distinct capacity and role to play in both the way that maize spread and the way that it became transformed. It is also useful here to distinguish between the voluntary and so-called informal trade networks from the formally organised networks based on breeding and selection programmes organised by state institutions in the country or outside Kenya, notably the United States and South Africa. The so-called informal networks involve the spread of land races, or what in this chapter we call local maize varieties. The formal networks on the other hand brought 'modern' varieties that were selected from exogenous germplasm and bred for its higher yielding capacity or better suitability for some of Kenya's ecological conditions. The analysis of these socio-technical networks will show that some of these networks overlap, coincide or amalgamate. Many of the maize varieties that came to Luoland through mechanisms other than intentional breeding programmes (e.g., through famine and relief programmes or labour migration are connected to maize breeding and selection programmes in the United States of America, South Africa, and later, Kenya itself.

The roots of maize in Luoland can be traced back to the late 19th century. It was introduced and spread through four different networks (see Table 1). Trade networks were the first of these. Portuguese traders were the first to bring maize to East Africa in the 16th and 17th centuries (Acland 1971:124). Initially (up to the end of the nineteenth century) maize growing was limited to the coastal areas but later spread inland.¹ The Caribbean flint

types imported by the Portuguese are still found in the coastal regions of East Africa and, to a varying extent, among local varieties inland. Their spread accelerated with the opening of the interior to external contact in the latter part of the 19th century. Captain Grant found reported that Maize was 'very rare' in 1863, but by 1897 H.H. Austin found the slopes of Mt. Elgon were 'thickly cultivated with bananas and Indian corn'. In 1901 Sir Harry Johnston found 'Indian corn everywhere'. (Landlands 1965:217). These latter references show that European settlers established lowland varieties of maize in the interior of Uganda and Western Kenya before the introduction of white maize after 1900. Thus neighbouring Uganda was a major source of maize varieties that found, and still do find, their way to Siaya through trade relationships.

A second network hinges around *food and famine relief programmes* organised by the colonial and post-colonial state. These led to mostly yellow maize being imported from the United States, to deal with acute food shortages. Some was reserved as seed for the next planting season. In fact both colonial records and oral history ascribe the gradual shift to maize from sorghum and millet to a series of famines that occurred in the late 19th and early 20th century. A third network is associated with *labour migration*. People returning from working in neighbouring Uganda or on the settler farms in the White Highlands, or soldiers returning from World War I often bought back new varieties of maize with them. Different migratory patterns brought different varieties of maize. A fourth network is linked to the various, but different, maize *research, selection and breeding programmes* of the Department of Agriculture of the colonial and post-colonial state, as well as with the white settlers who were looking for new varieties that were better suited to the inland climate, which they invariably found in South Africa.² The yellow maize varieties imported from the United States as part of famine relief programmes also derive from breeding programmes. Recently, some NGO-like institutions such as CARE-Kenya and Lagrotech started breeding programmes that have a quite different emphasis to those linked to formal research and breeding networks. Thus the socio-technical network based on research and breeding programmes is not entirely homogenous. Maize breeding has evolved over time and in different directions. What these networks share in common is that they invariably brought yellow and white varieties of maize, rather than the multi-coloured ones that spread through trade networks.

Together these networks brought a wide range of maize varieties (see Table 1), the cultivation of which spread rapidly among the African population, until it became the most important staple crop in Kenya (Gerhart 1975:1-3).

The proliferation of maize in Luoland

It is not exactly known when maize was introduced into Siaya or which variety came first. When Lord Lugard visited Nyanza in 1890, he saw 'little or no maize' (Hay 1972:95). Travellers to neighbouring Uganda first noticed the existence of maize in central Buganda and Bunyoro by 1862 and in Acholi by 1880 (Grant 1965:216-219). Thus it is possible that maize travelled along the main trade routes from Buganda and Bunyoro to Mumias (North Nyanza) and spread from there into central Nyanza during the 1870s or 1880s (Wright 1949:61-81). Through contacts with Waswahili (people from the coast) and Arab traders in the late 19th century, maize almost certainly found its way to Siaya. Through such trade routes, varieties like *radier* and *rachich* (the multicoloured varieties of maize) entered Luoland. At the turn of the century other varieties surfaced in the region. Ogwang Madara explains:

'I was born in 1914. I first saw my father in 1918, the year when *Ndege* (the aeroplane) passed by in our village. My father was just returning from the First World War. During this time people would run and hide in their houses when the aeroplane was passing high up in the sky. People thought that the sky was tearing apart. My grandfather was still alive then. He and another friend were working as porters for the first missionaries who came here. When they went with the missionaries to Baganda, they came back with these seeds. By then people were just trying them. He told me that this was before the railway line reached Kisumu in 1901. On their way to Uganda, he could also see fields of sorghum inter-cropped with maize.'

A white variety (*rachar*) was already being cultivated but was not widespread. Two other white varieties that were first to arrive and are still being planted today are the *oking* and *ababari*. These varieties are locally referred to as *mzungu* (white) maize since they were selected and bred by white people and first introduced by the Department of Agriculture of the colonial government. Both varieties came as part of famine relief programmes. *Oking* was introduced during the great famine of 1906-1907. *Ababari* and possibly other white varieties were introduced following the great famines of 1917-1919. Farmers still plant these two varieties of maize today and they identify them by their physical (phenotypic) characteristics. *Oking* means hard in *Dholuo* and has hard (dent) grains that cannot easily be attacked by weevils. *Ababari* was introduced into Siaya in 1917 by Mr. H.H. Holden a Luo-speaking West Indian, who was employed by the Department of Agriculture. *Jaduong* Odar Masa told us that Mr. Holden came to their farm when he was very young. He gave them seeds of maize, which they called *ababari* because it was larger than the seeds of *oking* and other earlier varieties of maize like *radier*. *Ababari*, according to Odar Masa, means a 'great thing'.

Table 1 Socio-technical networks of maize in Luoland

Networks	Key actors	Varieties	Colour	Year	Sources
Trade	Traders	Radier	Multi coloured	1890s	Coastal areas of East Africa via Uganda
		Rachich	"	"	"
		Rachar	White	"	"
		Rateng	Black	"	"
		Rapir	White with red stripes	"	"
		Uganda White	White	1982/84	Uganda
		Kawanda	White	"	Uganda
Food and Famine relief	Colonial and post-colonial state officers	Oking	White	1916	Unknown
		Ababari	White	1917	Unknown
		Nyamula	Yellow	1928/36/82	United States
		Hickory King	White	1950s	South Africa
Labour Migration	Migrants and former soldiers	Radier	Multi coloured	After World War II to 1970	Uganda
		Rachich	"	"	Uganda
		Rachar	White	"	White Highlands/ South Africa
		Kazigo	White	1922	"
Maize research and breeding programs	Research, extension and stockists	Kenya Flat White	White	1960	South Africa
		Kitale Synthetics	White	1961	Ki tale, Kenya
		Hybrid 511, 512,	White	1964	Embu, Kenya
		Hybrid, 614, 622, 625, 626	White	1970-90s	Kitale, Kenya
		PAN 5195	White	1990s	South Africa
		PH1	White	1990s	United States
		Maseno Double cobbler	White	1996	Kisumu

Sources: Acland (1971) and farmer and traveler accounts

The spread of maize cultivation in northern Siaya took place earlier than in most parts of Luoland due to coercive intervention from Chief Odera Akango of Gem (in the North Eastern Siaya). According to *Jaduong* Ogwang Madara, Chief Odera Akango was an 'eye opener' to the people of Gem. He was a young chief who brought progress by force³. Everybody had to practice the farming methods of the white man. Although young,

he had a big home and a very large farm in Nyamninia village, where he even planted rice. He is remembered as a great chief.

'He was a ruthless leader, who was very strict with development activities. He observed seriously the date of planting. Once the elders had discussed the rain with the rainmaker, they were to plant immediately. Thereafter everybody had to plant. This was a must. Failure to do so you were caned. He hated lazy people and when he found them, he had them caned in public. He employed 30 askaris (soldiers) to look around for lazy people who did not cultivate their land and grew plenty of crops. These people were brought to his weekly barazas (meetings) and caned in public'.

Another informant, Jaduong Andrea Manyasi (who was born in 1912) echoed these sentiments of Ogwang Madara.

'Chief Odera Akango brought another white variety of maize when he came back from a visit to Uganda. This was somewhere in 1916. I was too young and I did not know much. My mother told me more about Odera Akango. Then soldiers who were returning from the First World War brought quite a number of maize varieties. In 1922 the Europeans brought another white maize variety, which they called kazigo. This variety cannot be traced now. When I was born, maize had already been introduced in Siaya. We used to grow radier and it used to do well. Wazungu (Europeans) brought yellow maize in 1928, at almost the same time they brought cassava'.

According to Andrea Manyasi, the first yellow maize came with cassava and sweet potatoes, which are drought tolerant crops. This yellow maize variety is still grown to date and is referred to as *nyamula*. Another local maize variety that is still grown in Siaya is *rateng* (black maize), which is common in the semi-arid areas. Its major advantage is its very short period of maturity (70 days). It can therefore potentially be planted later than other varieties. Its source is not known. Most farmers say that they just discovered it in their fields and continued propagating it. Other local multicoloured varieties are also grown in Siaya.

Manyasi recalls that the rain failed in 1936, resulting in a bad year and shortage of food in Siaya. Maize was imported from the United States of America and distributed to farmers as part of famine relief. Farmers tried to plant this yellow maize (*nyamula*) as well, but it differed from the first yellow maize that was brought by the Europeans and did not do very well.

At a later stage, the government introduced Hickory King maize and other varieties originating from South Africa to replace the yellow maize varieties. These responses to famine, (and the early activities exemplified by Mr. Holden) fit the general pattern of the colonial state being actively engaged in trying to introduce industrial crops (such as sesame and cotton in Nyanza) and improved varieties of food crops (see Kitching 1980).⁴ From the mid 1960s onwards various varieties of hybrid maize (such as H512, H511, H622 and H614) were introduced in Luoland and

the Siaya region. These, invariably white, varieties are the result of a fourth socio-technical network that is closely associated with planned state intervention and involves maize breeders and their breeding programmes in Kenya or elsewhere, as well as extension, credit, and marketing agencies. These maize breeding programmes will be discussed in the next section of this chapter. . These varieties are all bred by the Kenya Seed Company (KSC) in Kitale. At the time KSC held a monopoly position on the Kenyan seed market, but since market liberalisation in the early 1990's other seed companies are allowed to sell seeds to farmers. This resulted in more recent entries of hybrid varieties such as PAN5195 and PH1, which respectively are from maize seed companies in South Africa and the United States. These varieties (from Pannar and Pioneer) were issued to farmers in Siaya for almost free. Neither of these performed very well as our discussions with farmers confirmed, the seeds germinated poorly and fields where they had been planted had a desolate appearance. The spread of hybrid maize and the kind of varieties that were introduced will be discussed in detail later in this chapter. Hybrid maize is, however, not very popular in the Siaya region for reasons that we will discuss later. The most recent local maize variety, that is now widely grown in Siaya, can be traced back to 1982/83. It is called *nyauganda* (Uganda white) and found its way to Kenya through traders going to Uganda to purchase maize during the great famine of *Goro-goro*. It is quite popular in Siaya and widely cultivated. The *Goro-goro* famine, like earlier famines, triggered off state organised famine relief programmes. Again yellow maize from the United States was imported and the seed reserved for the next planting season. However, this variety (again) did not survive in the Siaya environment.

A very recently introduced white maize variety is the *Maseno Double Cobber* (MDC) developed by Lagrotech, a private seed company, and released in 1996. Although farmers were initially enthusiastic about MDC, it is no longer widely grown since farmers that have tried it have learned that yields decline when its seeds are used in the next planting season. Thus they continued to use more stable local varieties whose yields do not decline over time. (The difference between the breeding of the MDC and hybrids will be explained later on).

According to Cohen and Atieno Odhiambo (1989) the Luo generally responded in an ambiguous way to the introduction of white maize into the texture of Siaya life. In the twentieth century, the consumption of white maize meal in Siaya has been associated with 'Westernisation'. White maize first entered the local economy through the intervention of the colonial government, and the maize meal was first referred to as *Kuon Ongere*, the white man's *ugali* or white man's food. Those who went to school planted maize almost as if it were part of their curriculum. They valued maize and identified with the esteem accorded to it, and so maize

acquired another identity: as *kuon jonanga*, the *ugali* of the 'clothed' people. So, through a combination of pressure from colonial authorities and their agents in Siaya, and through appropriation of the special value to it by those coming to see themselves as new elite, maize gradually seeped into the diet and the production of the people. White maize was seen as a status symbol of local elites in Siaya (Cohen and Atieno Odhiambo 1989:64) and became associated with the adoption of new life styles, Westernisation and 'modernisation'. From this new elite the growing and consumption of maize gradually found its way into all segments of society (Van Kessel 1998:29). This perception was also extended to hybrid maize.

Technological regimes of maize: selection and breeding networks

Having described some of the phenomena concerning the proliferation of maize in Luoland and the Siaya region, we can now examine how to link the issues and social processes together. One way to do is to focus on the networks surrounding maize breeding and selection. Such processes are intimately linked with the way its cultivation spreads. For, it is through breeding and selection that maize is produced, multiplied, propagated and the planting material preserved.

We can distinguish here between *breeding and selection practices based on mass selection* and the *breeding of hybrids*. The maize from the mass selection and breeding network tends to float freely around the area and travels through trade relationships across the border with Uganda. This network seems to be locally specific and is organised around locally prevailing conditions such as taste preferences, cultural dimensions of farming, soil fertility and maturing characteristics. Such networks are socially and culturally regulated by the (changing) cultural repertoires of the Luo. The hybrid maize network on the other hand is based upon markets and specialised institutions in Kenya, and increasingly further afield, due to trade liberalisation and privatisation. Regulation in this network is basically based on the prevailing market and technology relationships. These two networks entail different actors, produce different artefacts, rely on different bodies of knowledge, and serve distinctive aims. Sometimes the two networks encounter each other and different bodies of knowledge that they generate and practise are contested. We will first describe the two different ways of maize breeding separately and then their interactions.

Breeding through mass selection

Local maize varieties are in a process of continuous change, through yearly mass selection of seeds from the previous year's harvest. The process of selecting seeds for the coming season begins in the field and is based on the *phenotypical* characteristics of the maize stalk and the cobs.

Only the large regular cobs are selected and only the seeds from the middle part of the spindle are used for sowing. Mass selection is effective in increasing gene frequencies for characteristics which are easily observed, such as plant type, dates of maturity, grain characteristics, disease tolerance, tolerance to drought and strength of the stalk. Other characteristics such as colour, taste and palatability also play an important role.

Maize is a typical open pollinated crop. In an open field, each plant has a different genetic composition and different individual characteristics. In practice, a farmer chooses his seed from desirable individual plants or cobs. The seed from these different plants are shelled, mixed, stored and planted *en mass* to produce the next generation. Practically all those farmers who select their own seeds for the next season do this. Through this process they reproduce their own local maize seeds. Their expressed preferences are for seed that matures early, can be grown under conditions of unstable rainfall, resists pests, has a reliable yield when cultivated without inorganic fertilisers and fits with specific end uses such as taste and palatability.

James Otieno Okatch, who resides in Nyaminia village, is one farmer who generates his own maize seeds. He first planted hybrid maize in 1989, when he and his wife took over his mothers' land following his mothers' death. But as he is the eldest son among three brothers, it was imperative that he had to *golo kodhi* before the families of the other brothers. In accordance with the principle of *golo kodhi*, he had to use family seeds, those passed down by his mother.. He was lucky to find some hanging above the fireplace in his mother's kitchen, which he used along side hybrid maize. He didn't buy fertiliser year as he was broke after the expense of his mothers funeral and he had enough *zebu* cattle to manure the hybrid maize and family seeds. After the funeral he returned to Nairobi, leaving his wife in charge of their homestead. To their great surprise the family seed grew better than the hybrid maize they had bought.

Most neighbours did not believe what they saw in Otieno's field. Many interpretations were offered. Some villagers thought that it was a blessing from Otieno's late mother as he had fed the guests well at her funeral. There was enough beer and food. The elders were pleased with Otieno, as '*he did not tie money in his pockets.*' Before drinking beer they poured a little on the ground to honour his ancestors. In 1991, Otieno returned home to live. The performance of the maize seed inherited from his mother remains a source of pride. He shows it to every visitor who has an interest in farming. Since nobody knows exactly what type of maize variety it is, Otieno gave it a name, zero-type. This maize does very well with organic manure alone and *striga*⁵ is virtually absent. Most villagers have bought these seeds from him to try them out. However the majority of them,

including his brother, lost them during the hunger period when they ate the seeds rather than preserving them. After this Otieno was unwilling to pass any more seeds to his brother and his brothers' family have been obliged to plant other local yellow maize varieties ever since.

Otieno generates these seeds through mass selection, which begins in the field. He uses a number of criteria to select the cobs that he will use as seeds the following year. First he looks at the stem, which should be big and strong, then he looks for stems with leaves, which should be big and healthy, third the cobs of the maize should be drooping downwards after attaining physiological maturity. According to him, this ensures that water cannot get into the cob when the maize is left in the field to dry. Fourthly, the cob should not open to expose the grains to pest attack and water penetration. Fifth, the maize stalk should have prop roots up to the third node above the ground to resist lodging. Lastly the spindle of the maize should not have less than twelve lines and should be well filled with the grains. Otieno learned these criteria from his parents. He does not know much about hybrid and prefers to stick to the family seeds. Through yearly mass selection, Otieno has managed to maintain the zero type successfully. Like many other farmers, he does not use storage chemicals to preserve the seed, but instead uses ash from burnt cattle dung or from sedges, which grow nearby.

Otieno is representative of farmers that have sufficient manure from their cattle pen and good family seeds. As a result they are no longer linked to the market when it comes to maize production. The mass selection network is part and parcel of a development pattern that is de-linked, or repositioned itself, over the years from the state and markets as institutions generating maize seed for 'development'.

John Ndugu, a plant breeder stationed at KARI-Kakamega Regional Research Centre, is not convinced of mass selection as it is

'not effective in modifying characteristics such as yield, which is governed by many genes and cannot be recognised by the appearance of individual plants or cobs. Mass selection takes place on the basis of phenotypic characteristics. These only to a limited extent reflect the genotype for the yield-components and mass-selection is therefore not an efficient breeding technique for increasing yields. The ineffectiveness of mass selection in increasing yields results from: farmers inability to identify superior genotypes from the phenotypic appearance of maize cobs, as the criteria for mass-selection is the phenotypes; superior plants being pollinated from both inferior and superior ones, so that high yielding potential is not produced in all its progenies, and lastly strict selection for specific characteristics, e.g. maturity or grain type, which often leads to inbreeding depression and thus reduces yields'.

According to this plant breeder, high yield is very important in plant breeders' agendas. However, as we shall see later it is not necessarily a high priority for most farmers.

Hybrid maize breeding and selection

Deliberate maize breeding in Kenya first started in 1955 (Ogada 1969:5). The starting point for the breeding programme was a local maize variety called Kenya Flat White which originates in South Africa. According to Michael Harrison, the 'father' of hybrid maize in Kenya, Hickory King, Natal White Horsetooth, Ladysmith White, Salisbury White, Champion (Potchefstroom) White Pearl, and Iowa Silver Mine were the most successful maize varieties introduced from South Africa. The colourful names of these varieties reveal their origins; they were 'white southern dents' introduced to South Africa before the Boer War from the southern United States. They in turn are derived from the Mexican dent race 'Tuxpeño'.⁶ Once transplanted to the Kenya highlands, these varieties became inextricably mixed, and formed the genetic basis for a new variety called Kenya Flat White. This is a variable but reasonably stable mixed population with large white kernels. The ears are large and cylindrical and on average contain 12-14 rows. The plants are tall and late maturing and are relatively resistant to leaf blight. Over a period of thirty or forty years these plants were selected by leading settler farmers. When the originals were re-imported in the 1960s from South Africa and North Carolina for trial they were much more susceptible to disease, and yielded less than the Kenya Flat Whites that they were compared with. Thus, well before the new Kenya hybrids were produced, local selection had produced a well-adapted parent population. It was fortunate that in Kenya maize was both a subsistence and an export crop, since elsewhere in Africa very little research was devoted to food crops compared to cash crops intended for export (Harrison 1970.:26)

The Kenya Flat White was thus developed through self-pollination from the varieties brought in by early settlers from South Africa (Acland 1971:12-6). This variety is best suited to highland climates for altitudes of between 900 and 2,300 metres (*ibid.*). The initial objective of the breeding programme was to increase yields of the maize varieties already present in Kenya and this work focused a great deal on the highland areas with a research station situated in Kitale. The programme developed rapidly and after only a few years was extended to include early maturing maize suited to the drier lowland areas. This work was started in 1957 at the Katumani research station in Eastern Province (Ogada 1969:8).

In 1959 germplasm was brought to the Kitale research station from different Central American sources. The introduction of these new genetic lines led to the development of a variety called Kitale Synthetic II that was commercially released in 1961 (*ibid.*:5). This new variety was used to breed I the first classical hybrid which was released in 1964.⁷ This had a yield potential that was at least 30 per cent higher than the Kitale Synthetic II⁸. The breeding programme initially intended to develop both

synthetic and hybrid varieties, as (even at this time) it was thought that small-scale farmers would not be prepared to buy seeds every year.

'Due to the yield advantage of hybrid seed, however, it became more or less impossible to sell synthetic varieties after 1964' (Harrison quoted in Gerhart 1975:4).

The breeding programmes therefore shifted towards exclusively breeding hybrids. This shift was strengthened by trials held in Kenya indicating that hybrids planted under 'traditional' husbandry conditions increased production by 35 per cent, while hybrids plus improved husbandry and fertiliser application raised returns by 300 per cent or more (Agricultural Input Review/World Bank 1985, vol. 1. Main Report, Chapter II.). As Gerhart (1976:56) concludes

'(...) although it is the combined package of practices (i.e., time of planting, good husbandry methods, rainfall regime.) that produces the most dramatic results, the use of hybrid seeds alone will raise yields substantially, probably as much as 50 percent under good conditions.'

It is widely accepted in agronomic circles that yields from hybrid maize are approximately 30 per cent higher than from local varieties. This perception is, as we will see later on, increasingly contested.

The production of hybrid maize seed is a process that takes four years.

'The basic theory behind the production of hybrid maize is that by selecting certain maize plant types and carrying out crosses in a pre-determined manner, it is possible to add together the good points of the parent plant types. When these good points are all present in the final hybrid plant, the effect is found to be much greater than the sum of the individual desirable characteristics'. (Stages and procedures in Hybrid maize production, KARI training course on seed technology, Kakamega, August 1997).

In this process deliberate selections are made of the characteristics sought in the final hybrid. Thus it is possible to create seed varieties adapted to specific environments. A primary focus of the Kenyan breeding programme was to adapt seed varieties to the wide differences in altitude (and subsequently, differences in rainfall and temperature). Kenyan hybrids are identified by three numbers. The first indicates the approximate altitude at which the crop has been bred: 6 for Kitale (at 6000 ft) and 5 for Embu (at 5000 ft), etc. The second number indicates the type of hybrid.⁹ The last number is a series number; a letter, which also denotes the series, sometimes follows it.

The disadvantage of classical hybrids, however, is that yields drop in succeeding generations and fresh seed should be purchased for every planting season. Thus, it is *not* possible to select seed from the previous harvests, which is the common practice when using local varieties. This is not the only difference between mass selection and hybrid breeding practices. Over the years Kenya has imported significant amounts of

exogenous genetic material for breeding purposes supplementing locally collected genetic resources.. Between 1964 and 1985, Kenya imported nearly two-thirds of all germ plasma accessions for breeding programmes, for the maize breeding programmes the figure was 88 per cent (Juma 1989 184-185).¹⁰ Juma (*ibid.* 190) comments that

'by emphasising increased food production as the main focus of breeding programmes Kenya has tended to drift towards a narrower genetic base in major commercial food crops.'

This shift does not, however, reflect the tastes of local consumers, who prefer greater variability in their food resources as well as the taste and colour of local varieties. Since beans and local maize varieties were introduced into East Africa, producers have been gradually adapted them to meet their preferences and those of consumers.. However, local knowledge about local varieties and taste and colour preferences are not the types of knowledge that informs R&D policy makers. The R&D community in Kenya has followed a different path, oriented towards maximising yields, with concomitant acceptance and adoption of monocultures, mechanisation and genetic uniformity.

Few expect the major breakthroughs that were made in the 1960s to be repeated today. Present targets are far more modest, they aim to increase e yields by about four per cent per annum. There is also a slight change of emphasis towards short-maturing varieties that are suited to double-cropping systems and inter-cropping. At the same time the environment in which breeding programmes are developed has changed. The Kenya Seed Company, is now a private company that has to satisfy its shareholders and their breeding programmes are now more market oriented. At the same time, KSC no longer enjoys a monopoly position, and must compete with other seed companies (such as Pannar and Pioneer from South Africa and the United States) who are now selling hybrid maize in Kenya.

One potentially significant innovation in the institutional landscape of maize breeding comes from a small private seed company Lagrotech (Lowland Agricultural Technologies) who released the *Maseno Double Cobber* (MDC) in 1996. Lagrotech started from the realisation of a group of plant breeders in the region that farmers in the lowland areas of Kenya are no longer keen on hybrid maize. They set out to develop a composite variety of maize that is high yielding but requires low inputs. Starting from local land races such as the Hamisi Double Cobber (a farmer-improved local variety from the neighbouring district of Vihiga) Lagrotech developed the MDC, which meets these criteria although not requiring inorganic fertilisers. However, Lagrotech does recommend the use of these to improve yields. Farmers can regenerate the seeds up to the third filial generation, beyond which yield starts to decline. These seeds are available in small (2-kg) quantities and at much lower prices than the

hybrid varieties. Between 1996 and 1998, farmers were very enthusiastic about this maize variety, but later they came to learn that its yield declines as they continue to reproduce it. In general however, farmers do feel that it is a better option than the normal hybrid, as it requires fewer inputs. They prefer however, to continue to look for more stable local varieties, whose yields do not decline over time.

Research on how to further develop the MDC is still ongoing. The Kenya Plant Health Inspectorate Services (KEPHIS) whose mandate is to test new cultivars of commercial seed for release in Kenya, does not test Lagrotech seeds and argues that the MDC should not even be on the market. However, the principal researcher of Lagrotech argues that

'the proof of the pudding is in the eating. Researchers who claim that their work is relevant for improvement of agriculture in the tropics should be given the obligation and the opportunity to test their ideas and put them in practice. It is on this basis that Lagrotech tries to come up with a maize variety that will be acceptable to my people.'

State intervention and hybrid maize: interlocking and distancing

The proliferation of local maize is very different from the way hybrid maize spread in the region. Hybrid maize came in the form of a technological package consisting of a series of recommendations. Like the mass selection and breeding of local maize it is embedded in a whole set of institutions and institutional arrangements. However, unlike the local maize, the establishment of the hybrid maize regime involved the state apparatus, parastatal companies, markets, farmers' unions, and so on, and was heavily reliant on foreign aid programmes and projects.

In the wake of the encouraging and visible outcomes of the breeding programmes of the 1960s the Kenya government initiated a national development programme aimed at increasing in the productivity of land and labour in maize cultivation. This programme involved disseminating a technology package, containing hybrid maize varieties, fertiliser and pesticides, and of a set of prescribed husbandry and management practices, notably mechanisation (Hebinck 1995:168).

This package presented through extension workers and extension programmes revolves around a set of nine recommended practices, presented in Table 2. A leaflet describing these is included in every package of hybrid maize seed.

An important aspect of the spread of hybrid maize in Luoland and the country at large is the institutional environment that was created to facilitate its spread. The Kenyan government launched an aggressive campaign through KARI, Ministry of Agriculture and Livestock Development (MOALD) the, then still state owned, KSC and the Kenya

Farmers' Union (KFA) to recruit and convince as many farmers as possible to grow hybrid maize.

Table 2 The prescribed hybrid maize technology package

1	Land Preparation: this should be made well in advance of planting and ensure a ready seed-bed clean of weeds at the onset of the rains;
2	Time of planting: planting should be made at the beginning of the rains, or shortly before;
3	Choice of hybrid: the right hybrid variety with respect to altitude and rainfall should be chosen.
4	Population and spacing: a high, but not excessively high, number of plants should be grown, this is achieved if planting is made in rows. The spacing depends on where the crop is grown.
5	Planting: two seeds should be placed in every hole and a later thinning should be made when the plants are 15 to 20 cm high. The seed rate is supposed to be 10 kg per acre.
6	Fertilisers: these should be used twice; at planting time when the farmer is required to apply 50kg of Diammonium phosphate fertiliser per acre and when the plants are at knee high after weeding when he applies nitrogen fertiliser at the same rate. .
7	Weeding: in addition to having a clean seed-bed early weeding is recommended and weeding should be a continuous process keeping the fields clear of weeds until the maize flowers;
8	Stalk borer protection: in order to prevent stalk borers (an insect attacking the maize) insecticides should be used on the growing maize;
9	Storage treatment against weevils: it is recommended that insecticides be applied to the harvested cobs before they are stored to reduce storage losses.

(Source: KSC instruction leaflet (in: Acland 1971))

The task of KSC was to multiply hybrid maize seed. The Kenya Farmers Association (KFA), as a wholesaler was responsible for distributing the hybrid seed, fertiliser and pesticides. It did so via a dense and efficient network of over a thousand licensed stockists in Western Kenya. Trucks that delivered *Coca-Cola* to the remote parts of the country always also carried hybrid maize seeds. The joint strategy of KSC and KFA was that participants at every stage of the chain, from factory to retailer, received a good share of the profit. Those profits provided incentives to sell as much as possible, which effectively made every stockist an extension worker (Gerhart 1976:9). For instance, Selina Okeyo a farmer in Nyaminia village stated that she received the advice to grow certain hybrid maize varieties from a KFA stockist.

George, who has been an extension worker at MOALD since 1968, recalls the early period of the hybridisation campaign and the important role that extension agents played in the dissemination of hybrid maize among farmers. They were charged with recruiting as many farmers as possible

in their areas. Contacts with farmers were made in many different ways. George himself had his 10 contact farmers he had to meet every week. Each season he had to organise field demonstrations in all the contact farmers' plots and teach farmers how to plant hybrid maize. These contact farmers had the task of spreading the hybrid maize message to other farmers in their area. This farmer to farmer contact was particularly important.

'But anyway, farmers learn more from other farmers than from extension workers. Often when you visit a farmer, other farmers are afraid to come. Immediately after you have left they will approach the farmer that you visited to ask what you came to do. So you must try as an extension officer to reach those farmers that are central within a community so that others can learn from them.'

He also had to pay individual visits to newly recruited farmers and help them with planting and the logistics of how to acquire seeds, fertilisers and pesticides. Every year George successfully used to organise a major field day on one of his best contact farmers' fields., Senior district and divisional government officials used to attend these days. They were supposed to throw their weight behind the extension workers in promoting government policies to promote hybrid maize. KSC field officers would also attend to meet farmers and sell their seeds. As it was cheaper to buy the seeds direct from the agents than from the stores, there was always a very good turnout on these field days.

Opinion leaders also became part of the hybrid maize proliferation efforts. George frequently approached church leaders in the region, since he noticed that the adoption of hybrid maize by church leaders often had a positive effect on the adoption rate by members of their church. Government officials like chiefs and assistant-chiefs also played a role in the promotion of hybrid maize at *baraza's* (public meetings) where information about topical subjects and current events was exchanged. Teachers of primary and secondary schools also popularised the growth of hybrid maize through young farmers clubs. *Jaduong* Patrick Odongo (80 years old) a retired primary school teacher was the headmaster of Muhanda primary school.

'When I was headmaster I encouraged the adoption of hybrid maize by allocating each class a plot to grow the crop. Each class was required to apply all the techniques that the extension officers recommended. Most villagers used to admire the school plots and this gave them a positive attitude towards hybrid maize. The students in their turn also urged their parents to grow hybrid maize.'

MOALD also organised agricultural shows where exhibits from the farms were displayed. George was always in charge of his division's stand at the agricultural show ground. He would collect the best exhibits from his best farmers and take them to their stand at the agricultural show ground

and he won several awards. Some of 'his' farmers who attended the shows used to visit his stand to learn more, which further motivated them to continue planting hybrid maize. Every year, there was series of week-long training sessions for farmers at Farmers Training Centres (FTC's) where they were taught about the virtues of and the right way to practise hybrid maize cultivation. Extension workers could recommend farmers who had adopted hybrid maize or who were potential adopters for these courses.

Early exposure is another factor that contributed to the uptake of hybrid maize in Siaya. Migrants who went to work on the white settler farms learnt about hybrid maize much earlier than others. When they returned to their villages for holidays, they brought hybrid maize with them. Abednego Ochieng for instance was born in 1950 in Kitale where his father was working as a mechanic a region known as the granary of Kenya, which is where he first saw hybrid maize. When Abednego returned to his village Muhanda in 1972, he decided to grow hybrid maize.

'I started serious farming in 1972 after completing secondary school. Before that, I tried teaching as untrained teacher in a primary school, but the pay was so low that I abandoned it. During this time the campaign for growing hybrid maize was at its peak. So I started straight away with hybrid maize. This is because of seeing its performance in Kitale and also having developed an interest in agriculture during my school days in Nyangori, which was very close to maize growing areas of Nandi district. I went to the Divisional Agricultural Office and told them my plans. The then locational extension officer Mr. Wasao very quickly organised a tractor for me and I had my plot dug for free. He issued us with a bag of fertiliser and 10 kg bag of H632. During those days we were being offered these farm inputs for free'.

With a strong backing from extension officers of MOALD, Abednego became a very successful farmer. He joined the ranks of contact farmers and his farm was frequently used as a demonstration plot for farmers in Muhanda village throughout the 1970s. He won various awards as the best farmer at district and provincial level.

In 1974 the District Agriculture Officer sent a tractor to prepare Abednego's plot for free. He was also given fertiliser and hybrid maize seeds for free. He was also 'assisted' in acquiring a loan from the Agricultural Finance Co-operation (AFC)¹¹ and received a lot of help with the work in his farm. He became such a well-known farmer in the region that KARI researchers used his plots for on-farm research and demonstrations, also supplying him with the necessary inputs. Students from Bukura and Egerton Agricultural Colleges came to his farm for their practical periods. In 1976 he was chosen to go on a field visit to Zimbabwe where he met farmers from South Africa from whom he learnt a lot about

hybrid maize. He also saw what Zimbabwean farmers were doing in their fields. This motivated him to work harder on his farm.

Another important component of the hybridisation campaign was the subsidies for fertilisers and ploughing that were available to farmers. Many farmers had their fields ploughed for free by the provincial government's tractor hire services in the 1960s and early 1970s. Kenya also has a long history of high levels of fertiliser subsidy (usually above 80 per cent), that go back to the 1950s (Gerhart 1975:11). The fertiliser subsidy, which was terminated in 1978, contributed substantially to the spread of hybrid maize in the country.¹²

A fourth factor that played a role in the spread of hybrid maize was its perceived profitability. Those who still grow hybrid maize (although in different portions), all share the belief that hybrid maize cultivation was, and still is, profitable. In their opinion the average yield gap between hybrid and local maize is sufficiently wide to finance the necessary inputs and make a good profit. The proximity of the National Cereals and Produce Board (NCPB) (some 6 km from their villages) depot that offers a ready market for their maize is also an incentive. From 1942 onwards the predecessor of the NCPB (the Maize Marketing Board) maintained guaranteed minimum prices for maize. George sees the creation of a market as contributing to the spread of hybrid maize.

'the government did not introduce hybrid maize for the farmers alone. It also had its own interest. It wanted to generate some income for itself. The government also introduced hybrid maize for commercial purposes. The government had its own agents to buy the maize, NCPB. So the government created a market for maize. They did not do the same for sorghum because sorghum could not be sold outside Kenya and it is also difficult within parts of Kenya. Although sorghum is much more adjusted to the local circumstances in the south of Siaya, maize was still promoted there.'

Jaduong James Wasawo a retired extension officer with 34 years experience recalls that, by the late 1970s, hybrid maize was far more profitable than any of the traditional crops.

'My calculations with farmers at the time showed that the net margin per hectare of hybrid maize was six times the net margin for the traditional sorghum and millet food crop mixture. Maize was seven times as profitable as one of the traditional crops such as cotton, and more than three times as profitable as sorghum inter-cropped with cotton.'

These higher returns per hectare made hybrid maize attractive to farmers facing a situation of increasing land scarcity. However, the increased profitability of maize was not due to output price changes favourable to maize, throughout this period changes in the price of maize remained comparable to that of competing crops. Other factors also influenced farmers' decisions:

'besides being a cash crop, maize was also a food crop, and therefore could be stored for consumption purposes if there were marketing problems. Maize, in addition, matured about a month and a half earlier than sorghum. This made it possible for farmers to sell stored maize for financing inputs at the beginning of the growing season, because a new maize harvest would soon be available to replenish their food stocks. While millet also matured early, low yields made it unsuitable as a cash crop.'

The market was designed and operated so as to minimise the risks of hybrid maize cultivation. Farmers were confident that maize prices would not drop at the moment they had to sell their maize to finance investments for the purchase of hybrid maize seed and inputs such as fertiliser (Gerhart 1976:14-15). Within today's neo-liberal discourse, the NCPB's role has been reduced substantially and private traders operate freely on the market.¹³ The minimum price guarantee has now been abolished. This system of a guaranteed minimum price and a relatively well operating market system, with nearby depots was in stark contrast to the marketing and pricing of the 'traditional' cash crops – groundnuts, cotton and sugar. These crops have been plagued by marketing problems, largely because of inefficient marketing boards.

The promotion of hybrid maize did not solely consist of emphasising its virtues. At the same time, local maize and other food crops like sorghum, finger millet and cassava did not receive sufficient coverage from extension officers. In the process, local maize, especially local yellow and red varieties, sorghum, finger millet and cassava came to be known as 'poor man's crops'. They were associated with backwardness and ignorance. Hybrid maize (which was all white coloured) was associated with progress. You were considered progressive if you grew hybrid maize. The combination of these factors and processes created a pro-hybrid maize attitude of 'modernity'.¹⁴ This change in attitude certainly facilitated the adoption of hybrid maize.

Despite all the different support mechanisms the adoption rate of hybrid maize in Siaya district was never very high in comparison to other parts of Western Kenya. In 1973 the uptake of hybrid maize for the whole of Siaya was still below 20 per cent, while districts like Trans Nzoia and Kakamega it had reached almost 100 per cent (Gerhart 1976:27). In other words most farmers in Siaya district decided not to adopt the presented hybrid maize package. Furthermore, the farmers who did adopt the technology package did not, in most cases adopt the total package. They adjusted, or redesigned, the package in many different ways (see Mango 2002).

Contemporary patterns of maize production: distancing

In an attempt to determine the contemporary pattern of maize cultivation in we conducted a survey in three of our research villages,. Forty farmers were selected at random in each village and asked what type of maize they were growing at the time of research. The results of this survey are shown in Table 3

Table 3 Type of maize grown by farmers in three villages

Type of Maize grown	Villages			Total	%
	Nyamninia	Muhanda	Muhoho		
No. of farmers growing hybrid and local maize	10	7	2	19	15,8
No. of farmers who have distanced from hybrid maize	20	22	21	63	52.5
No. of farmers who have never grown hybrid maize.	10	11	17	38	31.7
Total	40	40	40	120	100

The table shows that a majority of farmers have stopped planting hybrid maize. One difficulty with interpreting the responses to the survey is farmers who have planted hybrid maize once in their lifetime, often say that they always had planted hybrid maize. To avoid problems of interpretation like this we selected 23 of these farmers, through purposive sampling, to interview in more detail and try to understand the processes at work. We combined this information with field observations and offered them ideas as to why the initial adopters had distanced themselves in one way or another from hybrid maize. Of the sample, 22 farmers had at some time cultivated hybrid maize, of which only six were still growing it, all in combination with local maize varieties. Sixteen had distanced themselves from hybrids had reverted to growing local maize only, and one farmer has never grown hybrid maize at all. Most young farmers and in particular women farmers have never grown hybrid maize. Detailed discussions with these 23 farmers gave a whole series of reasons as to why the great majority of farmers do not use hybrid varieties. Farmers formulate their arguments in different ways, but they fall into three main groupings: *institutional failures and dilemmas*, *agronomic values* and *cultural values*.

Institutional failures and dilemmas

The issues related to market failures do not disqualify hybrids from an agronomic and/or cultural point of view, but hinge around the quality of relationships between maize cultivation and the set of institutions

surrounding and supporting it. For some people failures of this type do not constitute a reason to reject hybrid maize but rather to package and redesign the set of prescriptions that form the technology package surrounding hybrid maize. (See Hebinck 1990, 1995, and Mango, forthcoming for a more detailed discussion of this issue). For others these failures provide sufficient reason to distance themselves from the hybrids and the markets. One of the arguments for distancing from hybrid maize is the high costs of inputs, such as seed and fertiliser. This counters the arguments (brought forward earlier, and by the 6 farmers still growing hybrids along side local maize) that hybrid maize is a profitable crop to grow in Luoland. Lack of capital and of credit facilities to purchase the necessary inputs are also important issues. Difficulty in obtaining inputs and the perception that they (especially seeds but also fertilisers) deteriorate in quality were also mentioned as reasons to stop growing hybrid maize.¹⁵ Abednego, for instance narrated that

'growing maize as a commercial crop is not very economical. You use a lot of inputs and the output is not very encouraging. The farming practised here has got a lot of risks. Crops and animals are not insured. I do not like taking risks anymore. I am still servicing a loan I was given by the Agricultural Finance Co-operation. I do not have sufficient labour to manage the hybrid maize. Thus I have decided to plant local maize due to lack of capital. A lion can feed on grass when it reaches the worst. We are now opting for sorghum. Look at the lower section of my farm, I have decided to plant sweet potatoes there and the upper section I have decided to plant cassava as the soil in that upper part is more eroded and as such quite infertile but cassava does not need a very fertile soil. Besides these, I nowadays plant bananas which give me some income during difficult times. Fertiliser shortages are nowadays rampant. The government would rather re-export the fertiliser that has been brought by the donor agencies and make money instead of thinking about the farmers.'

The local frame of reference obviously is that during previous conjunctures, i.e. during the heyday of the hybridisation campaign – the markets for credit seeds, fertiliser, draught power, and so on worked. Nowadays there is a general reluctance to invest money earned through other sources (e.g. migration, remittances, odd jobs and so on) in cultivating hybrids. Selina, a woman farmer expresses this general distrust of the market:

'One other thing I forgot to tell you concerns the quality of hybrid maize seeds. Since there is market liberalisation, most of our good quality maize seeds are marketed in countries like Uganda, Tanzania and Rwanda. The government earns more money when Kenya Seed Company sell the seeds there. Big farmers in the Rift Valley Province take up the remaining good seeds. So what sometime reaches us is doubtful. Anybody can sell anything to you as hybrid maize seeds as long as it is dusted with the green chemical they use for real hybrid maize'.

Another issue that plays a role is the slimming down of the apparatus of the Kenyan State that has occurred, in accordance with the Structural Adjustment Programme of the International Monetary Fund (with the support of the World Bank). Since 1990, the government has implemented a retrenchment programme, which has included its extension service. Those leaving the service (through natural attrition) have not been replaced and the ratio of farmers to extension workers has been steadily increasing. In Siaya district this figure now stands at a 1000 to one and the geographical area that one extension worker is required to cover has almost tripled.

Thus most farmers do not get much support from extension workers for their problems with hybrid maize, and hence they distance from it. Some farmers told us that extension workers seem to have almost disappeared from their area and that they no longer get regular visits from them. Moreover, when they do visit they propagate hybrid maize despite farmers' reluctance to grow hybrids. Farmers feel that the extension workers who do visit are inexperienced and ill equipped, compared to those who they were used to in the 1970s and 1980s and that they have little new advice to offer.

The extension workers that were interviewed showed considerable understanding of why farmers are not eager to plant hybrid maize. Most extension workers have their own fields where they grow maize, and are confronted with the same problems. Some of these extension workers grow local maize from self selected seeds they generate themselves. They cite the same reasons for growing local instead of hybrid maize. This despite having a stable salary and being able to access credit in order to purchase inputs.

Despite understanding the circumstances of farmers, extension workers continue to present themselves (officially) as hybrid maize proponents. A government extension worker explains why.

'We are evangelists of hybrid maize and there is no way we can turn our back on it. We are promoting hybrid wherever we go, even when farmers do not prefer it. Personally I grow Uganda white. Let the government sack me but I will not hurt my family by engaging in impossibilities'.

This situation in a way represents a double dilemma. The extension workers are subject to pressure from their superiors to propagate hybrid maize to unwilling clients and hence are obliged cover up their efforts to support their clients' strategies that are based upon the distancing from hybrid maize.

Agronomic values

The second group of arguments hinges around agronomic issues, particularly the relative merits of hybrid and local varieties. (Although these cannot be entirely disconnected, from cultural related issues such as

taste). One of the most powerful arguments to stop planting hybrids and to return to local varieties is that local maize out yields hybrids when only farmyard manure is applied. Experience with local maize, the so-called zero-type,, provides a counter-argument to the claims of plant breeders that hybrids are superior in this respect.. When we visited James Otieno during one our maize variety collection tours he pointed at the samples of maize that we held in our hand, he gave us one of his zero-type cobs and said:

'Look here. See for yourself. This cob is much bigger than the hybrid you have in your hand. So what is your judgement?'

In close association with this, farmers also claim that hybrid maize lodges more than local varieties; that the cobs from hybrids open resulting in cob rot and bird damage; that they are less resistant to weeds, pests, diseases and sudden changes in weather conditions. Hybrid maize also takes too long to mature. .. In addition, hybrid maize does not store very well and is easily attacked by weevils.

A second series of agronomic arguments hinge around soil fertility and the application of fertilisers. Soil fertility has become a major issue in Luoland. Official recommendations for maintaining soil fertility through the application of fertiliser are strongly contested. People claim that 'fertilisers spoil the soil', and that 'the soil becomes addicted to fertiliser', and that fertilisers stimulate the growth of *striga*. Selina for instance claims that

'it is true that fertiliser spoils the soil. Particularly if it is used without applying organic manure. Phosphoric fertiliser has got a tendency of staying in the soil. There it changes the nature of the soil to be very fine, which can easily be carried away by wind or when it rains, the floods.. Water also does not get down into the soil. Personally I like using manure. If I use fertiliser, then I just put a little bit.'

Ochieng Monye grows both local maize and several cultivars of hybrid maize depending on the season. Alongside this he also grows sorghum. The hybrid maize is grown on trial plots where CARE-Kenya (an NGO) or the Ministry of Agriculture carries out demonstrations. At a distance plot he grows local maize. In some of his trial plots with CARE-Kenya he grows also local maize that is selected by CARE-K's extension staff. CARE-K is involved in varietal screening of maize to ascertain which one is suitable for that particular area. Asked why he has given a large acreage to local maize, Monye said that

'the advantage of local maize is that they are early maturing. The fact is that local maize is as good as hybrid maize. It does not demand a lot of input and is not as labour intensive as hybrid. Sorghum is even better as one weeding is sufficient for it. Local varieties are hardy and can resist pest attack in the

store. They can even be stored up to three years. Normally when I see local maize somewhere, I bring it to this place.'

Monye maintains that he is growing hybrid due to the encouragement he receives from extension agents. He used hybrid for the first time in 1985 and since then he has been growing at least one cultivar of hybrid maize. However he has some problems with the hybrid maize.

'Sometimes I do not get hybrid maize seeds in good time even when I prepare my land early. The seeds are not always available. Hybrid maize needs a lot of inputs. Hybrid 622, which is recommended for this place, but when approaching maturity the cobs normally open up. When it rains, the water gets inside the cob and it starts rotting particularly from the base. The opening of the cob also exposes it to serious bird damage. The stalk of hybrid maize is weak. It will lodge when there is a strong wind'.

Cultural repertoire and taste preferences

The third group of arguments captures the cultural elements that inform and shape agriculture. One issue of quality and values reflects the notion that porridge (*ugali*) from hybrid maize is light and less satisfactory than the *ugali* made from local maize. Some people, particularly the women, argue that *ugali* made from hybrids requires twice as much maize as *ugali* from local maize. Hybrid maize is also less sweet than local maize. In addition, certain local varieties are excellent when boiled, others are perfect when roasted; qualities that hybrid maize does not have.

'Ugali from hybrid maize is light and does not satisfy children easily. Children need to eat more of it. Local maize is tastier than hybrid maize when roasted or boiled. This is because local maize has high starch content and when in milk stage the grains have got higher amounts of sugar'.

Colour is a further argument in favour of local maize.

A second issue is that hybrids are not in line with the Luo culture of first sowing (*golo kohdi*) and first harvesting (*dwoko cham*). Hybrid maize is perceived as a strange seed and unlike local maize does not become part of the family seed, and is therefore incompatible with Luo cultural repertoires. It remains an 'outside seed' (*nyareta*).

When the long rains start in early February, Abednego prefers growing H626. It is long maturing but yields well. When the rains come later, he goes for H622, H614 or H512 or even H511. In the short rain season he grows H512. But,

'my wife is the one who plants local maize variety (Uganda white). She grows it because it is early maturing more or less like the local maize. She reproduces her own seeds'.

Abednego apparently does not seem to be very interested in growing local maize. When we sat down with Abednego during the long rainy season of 1997 we asked him which seeds he was going to use during the

golo kodhi ceremony. He said he will use Uganda white. When we asked why, he said, he has to follow the *golo kodhi* principle.

'I have to follow the Luo customs. I am the eldest son in my father's family and failure to do so might impede the progress of my other brothers in farming as they cannot put any seed in the soil before I do so. Once my remaining Uncle Odongo and my mother have planted, then I can also plant followed by my two younger brothers'.

When we asked which maize variety he starts with given that the maize must be ready before that of your brothers, he answered:

'In the ceremony of golo kodhi, it is required that you use family seeds. Most people do not understand what family seeds are but today I want to tell you the secret behind it. Family seeds are the ones that were passed on to us by our ancestors. They are the ones that we try to regenerate and in case of any calamity, we can use them to offer sacrifices to the ancestors. They are able to recognise them. Furthermore the first harvest comes from these seeds we use to brew beer from and that we offer back again to our ancestors during the ceremony known as fuachra.'

But, as always with local cultural repertoires, they are sometimes contested and reworked. It seems that if the relation between relatives is good, a solution can more easily be found for solving (some of) problems generated by *golo kodhi*. For instance when the mother of Oketch Bundmawi and Oduor Lomo was delayed in her land preparation activities and therefore could not sow in time, she just sowed a few square metres of maize, after which her sons started sowing their plots. When there are disputes between relatives – and these occur frequently – elders can use *golo kodhi* to display and continue their authority or to punish youngsters who in their opinion do not show respect to them. One other informant specifically mentioned that one way to circumvent the *golo kodhi* ceremony is to purchase seed on the market and plant them immediately, without bringing them home.

Conclusions

The two maize breeding and selection regimes differ substantially from each other. In this concluding section we compare these two regimes to summarise the main differences and similarities.

A major difference is that yield of the (classical) hybrid drops in succeeding generations and in order to retain the yield advantage of hybrids fresh seed must be purchased every season. If a grower uses second-generation seed, the resulting population is very variable, owing to genetic segregation, and yields are poor. Thus, it is *not* possible to select seed from the previous harvests, which is the common practice with local varieties. Hybrid maize seed production has to take place under specific and controlled circumstances. A major characteristic of hybrid maize

regime is that production is embedded in, and presupposes, the expansion of commodity relations, the commoditisation of the objects of labour, and requires the supporting institutions (such as commodity markets and knowledge exchange) operate efficiently. It also is designed to be fertiliser responsive and needs reliable rainfall patterns and relatively good soils. Furthermore, hybrid maize has a built in optimal planting time. If planting is delayed by two weeks yields may be reduced by 50 per cent. According to a trial done at the Kitale Research Station 70-80 kg grain/ha. is lost for each days delay after the first week of the rains. The time of planting is thus crucial for realising the potential of hybrid maize. This creates seasonal peaks in labour demand, which farmers mention as a critical issue.

All these characteristics are stark contrast with the mass selection and breeding practices that generates seeds that are (relatively) freely available and exchangeable. These local maize varieties do relatively well under conditions of stress (lack of water, no fertiliser application, etc.) and are more resistant to drought and variable patterns of rainfall. Although, labour is also a critical issue with local maize, the greater flexibility in planting times makes it is a less pressing problem.

Another major feature of hybrid maize regime is the emphasis it places on the organisational and institutional arrangements for the production, import and distribution of inputs. The externalisation and institutionalisation of farm related tasks in specific institutions such as seed companies, financial institutions such as banks, extension services and advice, marketing bodies, seed quality control centres, and input distributors is imperative for this regime. The technology associated with the high-yielding maize varieties is not a merely a package of physical inputs, it also incorporates a package of new agricultural practices. The new technology follows a new crop calendar, given the longer maturing period of the new maize varieties and brings about changes in cropping patterns and crop rotation, as farmers are advised not to inter-crop with other food crops such as beans. Each of the 'new' inputs brings with it a new set of agricultural practices and recommendations. The farmer must now know how much seed to plant, how much fertiliser to apply on which type of soil, when, and what proportion of nitrogen, phosphorus, and potash to use. Similarly, the farmer must understand which type of seed is vulnerable to which type of pest, and what are the various options for pest control, with varying implications for timing in the use of chemicals, human labour, crop pattern and rotations. Maintaining relationships with research and extension and advisory agencies is critical in the production of hybrid maize, although this is not always easily achievable.

The local maize mass selection and breeding regime, on the other hand, is not embedded in such institutional arrangements, but is distanced from

them, and is predominantly shaped by non-commoditised relationships and the character of the local society and economy. The way the Luo breed local maize, select, exchange and produce seeds is largely fashioned by localised institutional arrangements such as *golo kodhi* and *dwoko cham*. Despite these being sometimes contested, they remain part and parcel of the dynamics of the local technological regime. In contrast, the establishment of the hybrid regime is (or was) the product of a project implemented by the state apparatus, which in turn was enrolled, and supported, by foreign aid relationships. In the 1960s this was the cornerstone of state agricultural policy, which aimed to increase productivity and attain national food self-sufficiency (Hebinck 1990:209 ff.; National Food Policy paper 1981:1¹⁶). It represented a 'new' technological regime that prescribed and shaped agricultural development towards operating within the domain spanned by markets and technology supply (Hebinck and van der Ploeg 1997).

The hybrid maize regime is very distinct from the mass breeding of local maize networks in that it is the outcome of ongoing 'progress' in agrarian sciences, notably in plant breeding, production ecology, soil science, agricultural engineering and agricultural economics. The development of this technology package has been accompanied by, and predicated on, the assumptions and the perception that hybrid maize is a profitable crop for farmers to grow (as it increases the returns to labour), and that it is superior to local land races, as it out yields them. Scientific knowledge (of breeding and selection) in other words, is presented as superior to local knowledge, which then is, or becomes, superfluous. The starting point has always been the technological superiority of hybrids over local varieties. One may question, however, whether hybrid maize varieties really do produce higher yields than local varieties or whether they have contributed to an increase of food security at household level.¹⁷

The mass selection of local maize, in contrast, hinges on a technological regime of local knowledge regulated by institutions such as kinship relationships and seniority. Cross border trade and exchange among kin and neighbours are the means by which it proliferates. Preservation and (re)production is shaped and characterised by non-commoditised relationships and the character of the local economy. The local ecology plays an important role as an endogenous resource, and as a gene pool for further experimentation.

Interactions between the two different technological regimes have taken specific forms. The 'modern' and hybrid maize varieties that are bred through the application of scientific principles do not fit with cultural practices, and as a result are no longer widely planted. Farmers who still plant hybrids do so in a redesigned way. This suggests that there is hardly any interaction or at least an interaction with a limit impact. Secondly, the results of earlier breeding programmes (invariably undertaken outside

Kenya) brought varieties through early colonial state interventions. These varieties still feature today and, most certainly, have added to the existing regional gene pool. The hybrid maize regime on the other hand has never completely managed to fulfil its 'mission' in the region. It is now being contested and criticised by scientists (e.g. plant breeders) themselves. The Lagrotech seed company shows that alternative ideas and practices are emerging from plant breeding circles, evidence that the technological breeding regime, based on the scientific principles of breeding, is neither homogenous or fixed. A variety of approaches to maize breeding exist at present in Kenya. If the technological approaches interact more regularly with the mass selection and breeding regimes then there is hope for the future.

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Notes

1 By 1643 maize was being grown on Zanzibar and Pemba islands to supply the Portuguese garrison at Mombasa. There is some evidence that it spread inland along the routes followed by the Arab slave caravans. Among the Nyika of Tanzania the root word for Maize is 'Pemba', which is presumably derived from the island Pemba, which was a base for Arab slave operations in the area (Miracle 1966:113).

2 This is not surprising as a lot of Kenya's white settlers originate from South Africa.

3 He was the chief of Gem region between 1915-1916.

4 In spite of the enormous support for white settler and estate agriculture, colonial state officials stationed in the Reserves, in Nyanza and Kikuyu land in particular, encouraged cash crop production by Africans. The fact that some sections of the colonial administration were actively engaged in encouraging agricultural development in the Reserves might be read as an indication that the colonial state was not a monolithic apparatus and was capable of perceiving wider interests, beyond those of white settlers. However, such support was largely motivated by the desire to generate cash incomes for Africans to pay tax in money instead of in livestock, which the administration then had to dispose of.

5 A virulent form of weed that competes with maize.

6 During a 1959 visit to Mexico, Harrison reported, he saw true Tuxpeño ears and found them 'indistinguishable' from their long-removed Kenyan cousins (Harrison 1970).

7 Commercial production of F1 hybrid seed began in the early 1930s in the United States and developed quite rapidly. In the early 1930s the area of hybrid maize in USA was only about 0.4 per cent, and in 1956 about 98 per cent. This success made the USA the biggest maize producer and exporter in the world both by volume and value (Song 1998: 79, see also Kloppenburg 1988). Following its wide adoption in the USA during the 1940s, hybrid maize spread quickly throughout the developed countries, and also aroused interest in the developing world. However, the results in most developing countries were not good, though there were a few cases of successes, in Zimbabwe, Kenya and northern part of China in environmentally favoured areas (*ibid.*: 79). The spread of hybrid maize and the institutional framework, in which it is embedded to the so-called Third World, was one of the features of *The Green Revolution*.

8 Selection of synthetic varieties is done differently. These are formed from a large number of inbred lines and have a greater genetic variability. Thus it is not necessary for farmers to purchase seed every year (Ogada 1969:5). A development from the classical hybrids are the composite varieties, varietal crosses, bred with the aim of retaining a larger genetic variability than is found in the classical hybrids. Composite varieties may be crosses of classical hybrids, crosses between hybrid and synthetic varieties or hybrid crosses with single inbred lines. These are also less sensitive to yield reductions in subsequent generations, but preferably, new seed should be purchased every year in the composite varieties (*ibid.*: 6). The genetic characteristics of the improved seeds will have consequences for the farmers and suppliers that significantly influence their adoption.

9 1 for a varietal hybrid (when a variety is used as one of the parents); 2 and 3 for classical hybrids (when inbred lines are used as the parents). 2 is used for double crosses, e.g. (GxD)×(A×F), and 3 is used for three-way crosses, e.g. (F×G)×G.

10 Similar trends can be noted in forest and livestock species. In 1985 nearly 95 per cent of Kenya's planted forests were exotic, and nearly 93 per cent of the germ plasma used in artificial insemination programmes was from exotic dairy breeds (Ayrshire, Friesian, Guernsey and Jersey) (Juma 1989:184-186). The reduction of the genetic diversity of local livestock breeds was effectively undertaken in the colonial period, although ownership of graded cows was restricted to the settler community (Cowen 1974)

11 Abednego never repaid the loan. According to him, he did not request the loan. However, he is still being asked to repay it.

12 Most of the fertilisers that Kenya imports are financed or donated under bilateral aid agreements.

13 Although that we did not collect data on this issue we strongly believe that the present maize consumption market is chaotic and characterised by price fluctuations, which create uncertainty for farmers

14 In Yala it became almost a taboo to provide visitors with *ugali* made from yellow maize or sorghum. As many people stated, women from Yala who married men from the South of Siaya, where more sorghum and local maize was grown, were often considered to be difficult in their new homes since they were reluctant to prepare and eat sorghum *ugali* and local maize *ugali*.

15 In an on-farm research report the CARE and the parastatal KEFRI support the notion that farmers lack confidence in inorganic fertilisers (CARE/KEFRI 1996:8).

16 Later versions of the Nation Food Policy paper (1994) echo the same ideas and images. The institutional framework has, however, changed dramatically due to privatisation and trade liberalisation. The KSC was once a major vehicle for the state for the implementation of its food policy; nowadays KSC is a private company that serves the interests of its shareholders.

17 This issue was already advanced in the mid 1980s by Greer and Thorbecke (1986).

12 Competing Wine Regimes: Some Insights From Wine Routes in Tuscany

Gianluca Brunori, Mariassunta Galli, Adanella Rossi

Introduction

Recently the Economist expressed disappointment on the state of world wine market: *'the globalisation of wine still has a long way to go'* (The Economist 1999). Despite the increasing market shares of the 'new world' countries, whose sales are strongly concentrated in very few companies¹, the European wine making model has successfully resisted the assault of extra-European wines and, perhaps, has even started its counterattack.

There was a period in which 'new world' model seriously worried the Europeans. It was a shock for the French, when in a blind test carried out in 1976, the most influential French wine critics awarded, higher scores to Californian cabernet sauvignon and chardonnay than to French ones. During the same period many of the most outstanding high quality wine producers in Italy gave up the 'Appellation of Origin' label so as not to be tarnished by the deteriorating image and quality, of some of the famous Italian wines such as Chianti. During the '70, wine-makers had a strong background in chemistry: for them, *'The quality of wine is 80 per cent made in the cellar, and 20 per cent in the vineyard'*. In a recent survey, most wine makers belonging to the generation of the '70s have a different viewpoint. For them *'the quality of wine is 80 per cent in the vineyard and 20 per cent in the cellar'*. For this new wave of European wine makers, the wine maker should only 'interpret' the grape: *'The only task of a good wine maker should be to understand the potentialities of each vineyard and valorise it'*.²

In the wine industry, the differences between the 'New world' and the European model are more marked than in other agro-food industries. There are only a few thousand new world producers are few thousands, compared to are hundreds of thousands of European ones. The 'New world' model relies mainly on technology, on efficient market operations, and on sophisticated market research to meet consumers' taste. The European model, on the other hand, is centred on the concept of *'terroir'*, which implies that the variety of soils, skills, cultures, landscapes can be translated into local products, whose characteristics are therefore unique.

During recent years, the strategy based on the concept of *'terroir'* has become far more coherent than during the '70s. Whereas in the 'new world model' wine is nothing more than a particular kind of beverage, and wine quality can be measured by precise quantitative methods, the 'European model' has developed a concept by which wine is far more than the mere material product. Like in the fashion industry, where *'people who enter in a shop are looking for romance, adventure, passion, mystery'*, people looking for wine increasingly look for a total experience, where symbols as, if not more, important than material aspects.

From the marketing viewpoint, the strength of the 'European model' is diversity. Californians can say that their cabernet is better than French cabernet, but Californian cabernet can hardly be contrasted with a 'Protected Designation of Origin' wine: simply, they are different, and the PDO cannot be replicated elsewhere. In a market driven by the search of diversity by consumers, big wine companies can diversify through branding strategies. Europeans have a natural and historical strategy for differentiation.

The concept of multifunctionality has opened new ways to further develop the European wine regime. Through appropriate actions, wine can be used as a lever for a far broader local development strategy. On global markets, wine communicates an image of a place, and that image can be used to attract tourists. This can also work in reverse: people visiting a place can enjoy local products and, having gained a taste for them, buy them again at home. Wine routes are among the most recent strategies to link agro-food production to rural development. The case presented here shows how these markets and the industry can be socially constructed with the decisive support of local forces, and how this construction can substantially change relations, even at the global level.

Alternative globalisations?

Restructuring processes in the global economy have made it clear that power and success in business are not necessarily linked to scale of operations. Rather, what matters is the ability to control others from a distance (Whatmore 1998), replacing hierarchical and vertically integrated organisations with networks based on a continuity between the 'inside' and the 'outside' of the firm (Saxenian 1994). This may imply subcontracting some operations, but also the creation of new partnerships with suppliers and customers (Peters 1992) or the centralisation of strategic functions (Harrison 1994) such as those linked with 'intellectual property': R&D, strategy and communication (Henderson 1998). As industrial firms reshape themselves to find new ways to compete at the global level, important forces lead to a general restructuring of economic regulation. National corporations and national trade unions lose (some of) their power to both trans-national and local institutions.

Rural development can be seen as one of the responses to the crisis of the post-war mode of regulation in agriculture and its techno-economic paradigm. Centralised state intervention, agricultural co-operatives and national farmers' organisations – the pillars of that mode of regulation in agriculture are losing their capacity to regulate the agro-food system and to respond to the emerging problems of farmers, consumers and citizens. New practices are starting to emerge, based on alternative techno-economic principles and embodying a reshaping of local-global relations.

One of the key points of rural development practices is *collective action* at the local level and its capacity to create alliances with the outside world. Collective action enables small entrepreneurs to mobilise social relations to improve their economic performance and create new opportunities for growth. Successful examples of rural development show that collective action produces a local frame of built environment, institutions, symbols, and routines which facilitates small firms' action by giving them access to resources that could not be accessed through acting individually.

The importance of collective action is not unrecognised within the modernisation paradigm. However, since the major principles of its associated agricultural development paths are scale and efficiency, it is mainly considered as a way to balance the power of the agribusiness by creating co-operatives (to reduce costs and concentrate economic power) and lobbies (to concentrate political power). In other words, it creates formal institutions with the purpose of centralising decisions and operations. Besides co-operatives and lobbies, the modernisation paradigm systematically overlooks the importance of other forms of collective action. For example, there is a scant recognition of the role of the family, which in the neo-classical model is only a source of labour power, and a systematic devaluation of pluriactive farming, considered an inefficient model of farm organisation. The recent 'rural district' approach (Iacoponi 1997) shows the theoretical importance of the economic role played by the relations within localised socio-economic networks.

Two of the most relevant outcomes of collective action in a wine route are synergy and coherence. *Synergies* can be defined as linkages between two or more entities, whose joint effort produces effects that are quantitatively and qualitatively greater than those produced by the efforts of the same entities acting independently.

$$E(a+b) > E(a) + E(b)$$

Coherence is a quality belonging to the elements that constitute the context of action in successful rural development initiatives: natural and built environment, social networks, and symbolic systems. When coherence is obtained, actors can more easily look for synergies.

Wine routes are a good example of how synergies and coherence work. In fact, a wine route can be seen as a network established around a theme:

'the landscape of wine'. The nodes of this network are wine farms, agri-tourist farms, producers of other typical products, restaurants, local authorities etc. In general wine routes are n^{th} ($n > 1$) level networks, since they are based on the integration of pre-existing social and economic networks. Once wine routes are successfully established, they create new markets, defined by new products and patterns of customer. These extend the product definition to all local goods and services related to wine and its territory (rather than only wine). In doing so, the routes focus on actual and potential tourists as customers rather than merely as consumers of wine.

Wine routes as collective action

A wine route is`

'a sign-posted itinerary, through a well defined area (region, province, denomination area) whose aim is the 'discovery' of the wine products in the region and the activities associated with it. This 'discovery' is carried out directly on the farms (enabling the traveller to meet the producer) and/or in the spaces specifically organised around the wine produced (wine tasting centres or wine museums)' (Gatti and Incerti 1997).

In practical terms, the tourists' journey along a wine route can include a range of experiences. These may include: a visit to a wine farm, with wine tasting; the chance to purchase wine; a visit to the vineyard; a visit to a thematic museum centred on wine or on other characteristics of the place; accommodation in an agri-tourist accommodation; trying the culinary specialities of the region; the enjoyment of a peculiar landscape; buying typical products of the region; and access to specific information on the place and its features.

Many of the reasons why tourists buy products and services from farms located along a wine route do not depend on the will or the ability of the single farmer. The event of buying depends on a preliminary choice to visit the wine route. Only once a tourist has chosen to visit the wine route does competition between farms start to play a role.

Figure 1 visualises some of the components of a wine route tourist experience as concentric circles. The larger the circles, the less the power of the single actors to modify a given situation. The horizontal line in the scheme divides what falls under the control of the individual actors from what is out of their control. The quality of on-farm hospitality or of the food served depends upon the ability of the single entrepreneurs, while tranquillity landscape or food variety are the results of collective action. Shopping becomes a component of a tourist experience (something more than just buying) when the items sold reach a sufficient variety within a coherent symbolic framework (being produced in the same region). The contribution of many producers is necessary in order to create this variety.



Figure 1 The components of a wine route tourist experience

The creation of a tourist experience around a wine route cannot be explained in terms of a mere sum of the output of the individual farms. The integration between the efforts of the farmers creates a *structured coherence* of symbolic and material elements, which adds value to the single products (wine, gastronomic products, accommodation etc.). The contribution of individual farmers to the shopping experience can consist, for example, of providing an additional item to the range; the organisation of the over-all range however is created by collective action.

In order to maintain this coherence, farmers must adhere to a common set of rules. These include: to keep the farm and wine cellar open to tourists for some hours per day; to be willing to inform the tourists about wine; and to be willing to invest in common initiatives in the field of communication and promotion (e.g. brochures, maps, participation at fairs). There are also non-written rules that facilitate the success of a wine route. A sensibility for quality of products, awareness of the importance of the landscape and attitudes to working reciprocally with other members of a wine route are all important unwritten rules.

The Costa degli Etruschi wine route

The *Costa degli Etruschi* wine route extends over more than 80 per cent of the province of Livorno³. The territory is characterised by a great diversity of landscapes. Travelling a few kilometres one passes from the coast to hilly inlands with areas of notable natural value. The sites that are particularly famous for cultural and artistic tourism, that characterise

other zones of Tuscany, are largely lacking in the area. Nevertheless, the territory is in a strategic position with respect to the most well-known tourist cities such as Florence, Siena, Pisa, Volterra and San Gimignano. The absence of cultural 'hot spots' is compensated for by the presence of many medieval villages of indisputable charm and architectural value. There is a high flow of tourists in the area, but this tends to be seasonal and linked to beach tourism. Quality food products are widespread in the area and have recently a large proportion of the entrepreneurs in the area have become involved in this. Agriculture is mainly based on pluri-active farming, which largely has been an adaptation of families to existing labour markets (tourism and manufacturing) (Brunori, Iacoponi and Miele 1990).

The area produces a number of high quality wines, some of which are internationally renowned. It includes three PDO (Protected Denomination of Origin) areas: Montescudaio, Bolgheri and Val di Cornia. The gastronomic and tourist offering follows an integrated strategy, that refers to the territory as a complex of artefacts, values, traditions and culture. It also involves several categories of actors (Pastore 1997), including producers (acting individually or in association), other economic actors linked to distribution (in some cases coinciding with the producers), those indirectly related to the eno-gastronomic activities (e.g. artisans), rural and agro-tourism entrepreneurs, and representatives of the local communities and institutions.

The idea for the *Costa degli Etruschi* wine route was proposed during the 1993 conference of the AIS (Italian Association of Sommeliers) and it was founded the following year. The provincial administrative office of Livorno was a major influence in starting up the initiative. It actively stimulated the creation of a Consortium, largely composed of private members, thereby building on the previous experience of the PDO consortia in the area. At present the board of the Wine route Consortium has ten members of whom 9 are private⁴.

The different phases in the development of the *Costa degli Etruschi* wine route can be outlined as follows:

- *The 1970s:* Some local entrepreneurs, aware of the fact that the territory is highly suitable for the cultivation of quality vines, introduce varieties (Carbernet, Merlot) that correspond to 'international taste'⁵. Some entrepreneurs begin to bottle their own wine in order to differentiate it from the 'mass product'. Following the example of wine-makers, producers of other products (olive oil, fresh vegetables, honey) start to give more attention to quality and look for short circuits to sell their goods.
- *The 1980s:* Wine production receives a strong impetus from the Consortium for the protection of PDO, which helps the entrepreneurs develop the first forms of co-operation with respect to promotion (local

fairs, presence at national and international fairs) and quality improvement. The first agri-tourist activities are taken up.

- *The 1990s*: Agri-tourism experiences a spectacular growth and diversification. Several farm-based tasting rooms are opened. The first agri-tourist guides are published, giving coherence to the agri-tourist supply. The *Costa degli Etruschi* Wine route Consortium is created. Artisans, traders, hotel-owners and others are involved in the network.

Presently, the 84 members of the Consortium include wine-growing farms⁶, agri-tourist farms, producers of honey, oil, home-made salami and traditional home-made jams, wine bars, wine shops, restaurants, camp sites, nature parks and hotels. The last group is a recent entry, but has been extremely important for some time as a vehicle for the diffusion of promotion material. Amongst the producers there are numerous organic farms.

The Consortium is not the only association in which wine producers are involved. Through the *Associazione per il Movimento del Turismo del Vino* (Association for the Promotion of Wine Tourism) they have been participating in the 'open cellar' initiative⁷ since 1992. Farms open their doors to the public on the same day all over the country and the producers personally receive visitors. Through the *Associazione Nazionale Città del Vino* (National Association of Wine Cities) the 'star goblets' initiative is promoted. Collective displays are organised on public squares of the sponsoring municipalities. In turn, this initiative is part of a wider calendar of events organised in many important Italian towns. Moreover, there also agri-tourist networks, PDO networks, networks of commercial brands etc. that are not directly related to wine. Farmers in the area are well aware of the importance of direct selling, contact with tourists and communication through fairs or brochures. In other words, there is a strong '*institutional thickness*' (Amin and Thrift 1994) and a widespread awareness of 'the power of association' in the area.

Socio-economic impact of the wine route

The social and economic impact of the wine route on the farms in the area is impressive. When a wine route is successfully established, it has two types of effects on farm activity. First, it increases the profitability of the existing activities, and second, it opens new opportunities for farm activity. We could call the first one a *localisation effect*, while the later might be termed *synergy effect*. Both effects add themselves to an *individual effect*, which is based on individual entrepreneurial ability. Localisation effects are experienced by all farms that, one way or another, are involved in the wine route. It does not require a particular effort from farmers, they simply benefit from a general growth of the competitiveness of the territory as a result of the wine route. Synergy effects, on the contrary,

consist of an active response of farms to emerging opportunities and imply changes in farm operations, their organisation and relations with their environment.

Figure 2 presents a general model to understand how farm revenues change as an effect of the wine route. Wine routes influence both the number of tourists coming to the area and the consumers' awareness of the distinctiveness of the territory. The first effect results in a growing demand for directly sold products and services, including wine, agri-tourist services, olive oil, honey, cheese and processed vegetables. Consumers' awareness improves the reputation of the territory as an area of production and allows it to differentiate itself from others. Reputation is turned into a premium price, or stimulates an enlargement of specific markets such as those for wine bottled and labelled on the farm. In fact, the on-farm bottling of wine acts as a sort of quality insurance to consumers, in that it links the wine to a specific territory.

At the farm level, the most evident effects of the wine route are related to prices. Table 1 summarises the prices for unbottled wine, olive oil and agri-tourist services obtained by eight member farms of the route, compared to average prices on conventional farms. As can be observed, the prices realised by member farms are substantially higher than for conventional farms.

At the farm level of analysis it is difficult to fully distinguish localisation effects from synergy effects, since they are strongly interconnected. From interviews a clear perception of the relation between prices and the adhesion to the wine route emerge:

'as soon as the German importers were told that our wine was produced by farms of the wine route, the demand increased and also the price raised considerably'.

Table 1 Comparison of prices between wine route member farms and conventional farms (Euros)

	Conventional Farms	Farm A	Farm B	Farm C	Farm D	Farm E	Farm F	Farm G	Farm H
Unbottled wine (per litre)	0.9	1.45	1.03				1.3	1.18	1.55
Olive oil									
- unbottled	4.13		6.45				6.2	5.68	7.23
- bottled	6.20				10.07	8.26			8.26
Agri-tourism									
- Prices per room/day	36.15		47.5						
- Prices per apartment/day	87.8	140.5			92.96				

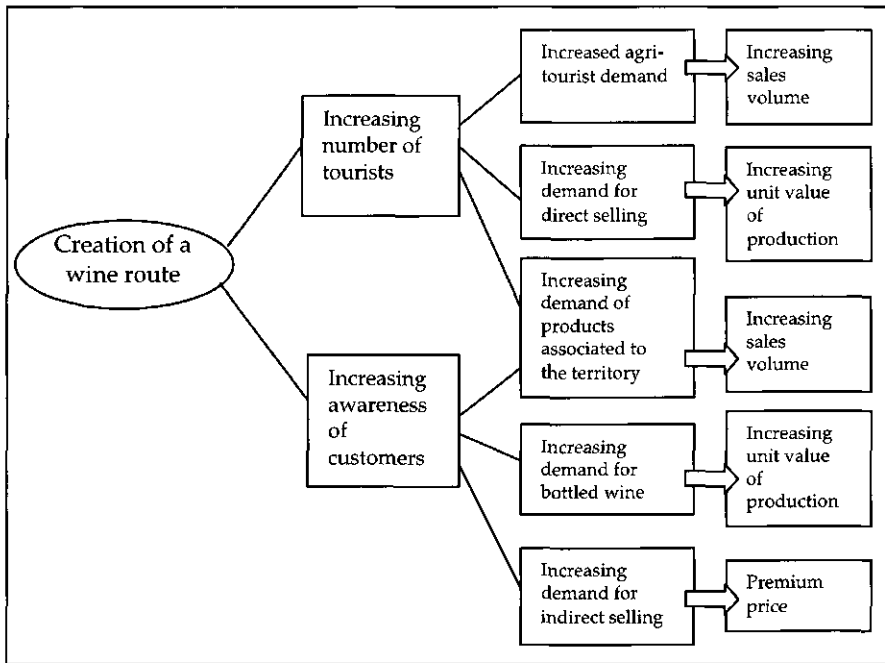


Figure 2 Effects of the creation of a wine-route

Increased reputation may also produce synergy effects: the increased number of contacts at farm level, for example, stimulates farmers to focus their strategy on direct selling. Once customers are 'captured' looking for wine, farmers try to increase the total value sold per contact by diversifying their basket of products or by increasing sales volumes. As a result farmers pay more attention to quality and the aesthetic aspects of the layout of the farm or invest in facilities to improve the attractiveness of the visit (tasting rooms, parking, seats, playgrounds for children etc.). Direct selling, together with an increasing share of produce processed on the farm, allows farmers to employ more family labour and increase the value added on the farm.

The growth of direct selling and the related reception activities induces changes in labour patterns and the development of new skills within the farm. While a direct relation between female labour and reception activities has not (yet) been demonstrated anecdotal evidence suggests that the creation of the wine route and the increased importance of services has strengthened the role of women on the farm.

Economic impact at the territorial level

The over-all impact of the wine-route at the territorial level, has been assessed in two different ways. The first is *synchronic* and compares farms

participating in the wine-route with a cross-sample of those who do not. The second is *diachronic* and examines the changes that participation in the wine route has brought to the involved farms. This later analysis has been done through documenting 'key-events' in the farms' recent history that have generated a discontinuity in farm management practices. Table 2 provides an overview of key events in the development of the wine route and assesses the effects of these changes on relevant economic variables and the delta value added.

Table 2 Analysis of key events in the development of the wine route

Year	Key event	Influence on delta	Critical data	Assessment at a farm level
1964	Unbottled wine for local consumption		1.4 euro / litre	
1968	Purchase new vineyard	Increase of production	Increase of production by 200 tons	
	Selling unbottled wine to wholesalers	Increase of turnover		200 tons * 500 Euro / 1 ton = 1000 Euro
1974	Membership of PDO	Increase in price	PDO premium between +20% and +110%	
1974-	Bottling	Increase of price Increased employment on farm	Price of bottled wine: from 2.5 to 5 Euro per bottle	22,000 bottles sold * 3.5 (average price) : 22,000*3.5 = 77,000 Euro
	Production of 'vinsanto'	Increased price Image improvement	Price of vinsanto: 18 euro / litre	1000 bottles of 0.75 litres: 1000*0.75*18= 13,500 euro
1980-	Refurbish old buildings	Increased land value		
	Starting agri-tourism activity		7 apartments at 137 euro per day per each (average 84 days per year)	7*137*84 = 80,556 euro per year
1998	Membership of the wine route	Increase of demand of wine Effects on agri-tourism		

The results of the analysis of key events were used for synchronic comparison, by evaluating what would have happened if these key events, brought about by the establishment of the wine route, had not occurred. This 'what-if' analysis was used as a basis for simulating the effects of membership to the wine route. These included: an increase in selling prices (*price effect*); changes in sales patterns (direct sale versus wholesalers) (*selling effect*); changes in working patterns and volumes (employment effect), and; changing production patterns (e.g. bottled versus unbottled wine, increased agri-tourist activity, increased share of high value-added products) (*production effect*). The simulation was carried out by varying the three most relevant elements affected by the wine route: price increase, shift of production from unbottled to bottled wine, and a shift from wholesale to direct sale⁸.

The results of the simulation (Table 3) on the 60 farms belonging to the wine route (which we have called *actual* impact) show a delta added value (calculated over the total revenues) ranging from 30 per cent (which we call the *prudential* estimate) to 40 per cent (which we call the *optimistic* estimate) of the initial farm revenues.

Table 3 Actual impact of the wine route on delta value added at territory level (Euros)

	Total revenues before membership	Prudential delta	Optimistic delta
Wine	2,906,000	871,800	1,162,400
Olive oil	325,000	97,500	130,000
Agri-tourist activities	367,500	110,250	147,000
Total	3,598,500	1,079,550	1,439,400

Table 4 shows an evaluation of the potential impact of membership of the route on the wine, olive and agri-tourist farms within the area, who have not joined the wine route. The total revenues have been estimated on the basis of the land cultivated with olive trees and vines, and on the number of agri-tourist rooms. In this case, we have considered as realistic a membership rate of 80 per cent (of the land area cultivated with olive trees and vines). We refer to these results as the *potential* impact, as they show the impact at territorial level if these farms were to join the wine route. As before we have calculated prudential and optimistic estimate of the delta added value, but at a lower rate than before (respectively, 15 per cent and 30 per cent) since we have assumed that the late comers will not enjoy the individual effects to such a great extent.

Table 4 Potential impact of the wine route on delta value added at territory level (Euros)

	<i>Total revenues before membership</i>	<i>Prudential delta</i>	<i>Optimistic Delta</i>
Wine	24,580,000	2,949,600	5,899,200
Olive oil	9,500,000	1,140,000	2,280,000
Agri-tourist activities	2,520,000	378,000	756,000
Total	36,600,000	5,490,000	10,980,000

(*) calculated on the 80 per cent of the land with vineyard and olive gardens

Synergy and coherence: some theoretical insights from the case-study

It would, of course, be highly unrealistic to assume that all wine routes can be so successful. In Tuscany, about 14 wine routes have been, or are being, established, but not all of them will be so successful. Success or failure can depend from many causes, but there are some internal factors whose presence or absence can play a decisive role on the outcomes. The impact analysis, therefore, should be based on a sound theoretical awareness of the processes activated by the establishment of a wine route and on a clear understanding of the concepts of synergy and coherence.

Synergy is power '*in potentia*', which has to be mobilised by action. It has to be transformed into power '*in actu*' in order to produce effects (Latour 1986). Synergy can be analysed as the result of two phases. To create synergy with B, actor A first needs to establish a link with one or more elements of his/her environment. Second A and B need to perform one or more joint actions in order to reach a common goal. The first phase is clearly the most difficult aspect of the process of synergy creation. In order to establish a link with B, A should be aware of B's existence, and overcome the barriers (physical, ethical of trust or communication) that separate him/her from B. It is for this reason that pre-existing social networks are so important: they form the basis for further interaction (Putnam 1993; Williams 1988).

Once a link between A and B is established a joint action can be undertaken. The joint action can be repeated, and generally the cost of performing a joint action is lower the more joint actions are performed. In the case of repeated actions, synergies can be classified into static and dynamic synergies.

- Static synergies occur, when the effect of a repeated joint action is the same as that of the preceding one: $E^{i2}(a+b)=E^{i1}(a+b)$.
- Dynamic synergies occur, when the effect of a repeated joint action is greater than that of the preceding one: $E^{i2}(a+b)>E^{i1}(a+b)$.

The modernisation paradigm almost exclusively takes into account static synergies. Scale economies and bargaining power are the result of the centralisation of action(s), not of their repetition. The emerging new rural development paradigm, on the other hand, embodies a systematic search for dynamic synergies. At the basis of dynamic synergies are 'positive feedbacks'. Effects of a previous action become an input for the repeated action, and thereby amplify the effect of joint actions (Krugman 1994).

A basic form of synergy is *complementarity*, that is the combination of different types of resources to perform a task. In a family farm, different skills and characteristics are combined together to fulfil a range of necessary tasks. Through relationships with other farms or rural enterprises, a farm can have access to resources that are not internally available. For example, an agri-tourist farm or a rural shop might face a demand for goods and services that are not produced on the farm itself. This may stimulate other producers dedicate part of their production to fulfil this demand. Along similar lines, organic farming can stimulate a local market for organic inputs.

A particular form of complementarity is *hybridisation* (Featherstone and Lasch 1999). In this case, the occurrence of synergy depends on the ability of the actors of a network to create communication between spheres of activity, which are culturally or technologically distant from each other. In the 1970s, before the *Costa degli Etruschi* route existed, there were already some tourists coming to the area from the coast and several farms benefited from this by selling directly. There was however no clear realisation of the potential of the linkage: agricultural activity was strongly embedded in the '*filiere*' and tourism was still considered as a separate sphere. The development of agri-tourism has crossed this cultural boundary and showed that the relationship between tourism and agriculture can be much more than an occasional one.

Innovation in the *Costa degli Etruschi* wine route is strongly based on hybridisation. There are numerous examples of this point. Farmers come into contact with the cultural world of tourists and progressively learn to communicate with them. Locals returning to the rural world after living in towns or cities bring with them the knowledge, skills and tastes they acquired there. Organic and other 'alternative' farmers show conventional farmers new ways to embody added value or reduce costs.

Synergies also depend on the size of networks, the volume of exchanges between nodes and the number of activities performed. Scale economies therefore continue to play an important role, although in less pronounced and actively pursued ways than before. Scale economies are directly related to the volume of the output produced by each operation, but as Rullani (1998) has pointed out are not necessarily obtained at firm level. Rural development experiences indicate that scale economies are more

frequently obtained at the level of the relevant local network. For example, the costs of quality control for producers of wine or PDO products are much lower when the number of controlled farms increase.

Another interesting example of scale economies in the wine route concerns bottling. As indicated before, an important effect of the wine route at the farm level is that more wine is now sold in bottles. A bottling machine with a high level of automation is however rather expensive, and labour is often too scarce to allow manual bottling. Many farmers therefore hire an on-farm bottling service, that does the work with a mobile bottling machine managed by a specialised entrepreneur. The existence of this service in the area is only possible thanks to the presence of a large number of small producers. They supply the 'critical mass' needed to make the service viable.

Scope economies are probably amongst the most representative synergies underlying rural development. Contrary to scale economies, scope economies are based the variety of applications for the same resource (Morroni 1992). The most established examples of scope economies at farm level are pluriactivity and farm diversification, both of which are important structural aspects of farming in the area of the wine route. For these activities the family represents an essential organisational resource, for it is within the family that labour can be allocated across different tasks within several fields of activity. The high level of interaction within the family, based on trust and reciprocity, allows for processes of learning and the transfer of knowledge between different fields of activity. For example, cooking skills of housewives are transferred into agri-tourist catering; or marketing skills that a family member acquired during work in a supermarket or restaurant on the coast are applied to farm strategies. Diversification of the farm allows principles learned in one field of activity to be applied in others. For example, producers in the *Costa degli Etruschi* route, quickly started applying strategies that proved successful for wine to olive oil: bottling, accentuating the quality level and selling directly or through specialised distribution channels.

Another example of scope economies can be found in the wine route consortium. Its main tasks are to represent the wine route members at an official level and to establish and enforce rules concerning the quality standards of products and services. Yet progressively the consortium has enlarged its scope to all activities linked to communication. It organises special events, facilitates joint participation in important fairs, develops public relations and recently created an information centre. With increased activity farmers at times are too busy on their farms to always accompany tourists on a guided tour to the cellar or the vineyard. Now the information centre collects the requests and organises the tour on

behalf of the farmers with specialised personnel. Once established an information centre can broaden its scope, extending its activity to all tourist attractions of the place.

The size of the network can also affect its performance. *Network economies* (Capello 1995) are based on the increasing utility of belonging to a network when the number of nodes increases:

$$U(Nn+1) > U(n)$$

The more nodes a network has, the greater its attractiveness as more intense information flows and positive feedbacks occur. Network economies are particularly evident when considering the relationship between the tourists and the producers within the wine route. Each farm can be conceived as a 'point of connection' for the tourist to the network. When reciprocity exists, each actor of the network co-operates to give tourists access to it. No individual farm can offer all the goods and services the tourists need on their journey. By using network relations combinations of goods and services can be offered at different points of the network. A similar type of network economy occurs when farmers give advice to tourists on where to go to buy specific products. Since network relations are strong, what farmers learn through their interaction with tourists rapidly circulates through the network.

Alternative networks and hegemonic strategies

The establishment of an alternative network is not without conflicts. A successful strategy needs to overcome many obstacles and to be supported through strong alliances. The creation of the *Costa degli Etruschi* wine route can be considered as an outcome of an empowerment process by a group of producers bringing about innovative ideas.

In the 1970s the emerging alternative wine networks drew on economic, organisational and cultural resources that deviated from the repertoire that was available in agriculture at that time (which was mainly based on the modernisation paradigm). The process of integration started with 'pioneers', who discovered the cultural and historical aspects of the territorial repertoire and introduced them into farm activity. In the beginning these people were considered 'eccentric' by other farmers and received little or no support from the local techno-institutional environment. Now they are the winners, and their ideas have become the norm in the area.

In order to consider how alternative networks are central to a strategy to create an alternative regime, it is necessary to understand more deeply how empowerment is obtained and what factors facilitate it. Empowerment can be defined as the process through which individuals or groups increase their capacity to control their environment. Locally distinctive products are a way to defend local agricultural production

from the centralising influence of the mainstream food industry. Organic farming gives control of the production process back to the farmers. Fair trade establishes more equitable contractual terms. Wine routes establish steady relationships between tourists and the territory.

As social relations are progressively separated from local contexts of interaction (following Harvey 1990), empowerment should be analysed both in terms of controlling place and controlling space, respectively being able to control the local environment, and to control others at a distance (Whatmore and Thorne 1998). Wine routes help producers to better control place, as they have more autonomy over how they sell wine and to establish multifunctional relationships with the territory. They are also more able to control space, as they can communicate directly with end consumers through their labels and through creating distant relationships through the trust generated by farm visits. .

Increased control of place can reduce domination from external forces and counter the effects of globalisation which threatens to control place through exogenous mechanisms.. Powerless actors can reduce their dependence on external forces, by setting up alliances at a distance. Alternative agro-food networks provide these powerless actors with resources to better control their environment. In order to be produced, shared, and exchanged, these resources need specific languages, rules and infrastructures. Resources of empowerment fall into four domains: economic, social, technological and symbolic.

Economic power

In business, economic power has several sources: availability of capital, bargaining power and competitiveness. This last component covers both the capacity to impose lower prices on products of the same quality and the capacity to get premium prices from products of equal or higher quality. Alternative business tends to redistribute economic power: wine routes have an immediate impact on bargaining power of the producers, as they can rely on alternative distribution channels, and therefore they reduce their dependence on wholesalers. Moreover, they get premium prices, which at least in part is due to their symbolic power.

Social power

Once established, social networks create trust, solidarity and sociability. They support their members in facing troubles or in distinguishing them from their competitors. They shape the public sphere and allow their members to have a common voice on public decisions. In other words, social networks provide platforms to start alternative activities.

Technological power

One of the keys to the development of alternative networks is its capacity to create new patterns of relations with non-human elements: natural and

man-made. Technology is the level of scientific knowledge embodied into artifacts and production techniques; the application of science allows for more rapid improvement and for their circulation. The growth of alternative networks generates a demand for research, so that the principles on which local distinctiveness and organic farming are based gain increasing attention and legitimacy in the academic field, allowing an accumulation of knowledge. In the case of the wine industry, as '*terroir*' becomes a relevant aspect of success, a new generation of wine makers has emerged, who have the ability to create connections between taste and local distinctiveness, and whose skills and competence shift the focus from the cellar to the vineyard and to the local environment.

Symbolic power

Symbolic power can be defined as the capacity to influence identity and its projection.. Identity is a symbolic representation of the meaning that social actors give to their actions (their role, rules of behaviour, the principles to follow, lifestyles, etc.). The symbols of the presence of a wine route (road signals, information centres, brochures, events) strengthen its presence increasing social recognition and legitimacy; they are indicators of a successful hegemonic strategy.

The interplay between economic, social, technological and symbolic power

These resources can be mobilised to obtain more resources in other domains. For example, financial capital can be used to get more social power through influence in politics and reciprocity and trust within a local community can be capitalised into local production systems as means to facilitate information flows and innovation (Putnam 1993, Gambetta 1988).

The way to mobilise resources is to provide them with gateways or interfaces, points of connection and of active translation of the flows of one network into others. Actors who occupy the position of gateways can, for example, convert commercial standards into local forms of organisation, languages and knowledge (Marsden 1998). Another way used to mobilise resources is to use already existing networks (e.g. informal economies based on kinship or neighbourhood networks) as conduits for new resources and ideas.

Symbolic power has a direct effect on economic power through premium prices. One of the keenest areas of competition between firms is that of image building and brand portfolios. Alternative networks enjoy one major advantage *vis-à-vis* conventional business in this respect. In order to acquire symbolic power, the only resource available to conventional businesses is their ability to mobilise economic power, that is to employ financial capital (Figure 3). By contrast alternative businesses can mobilise symbols whose strength derives from other spheres of activity. In the case of organic products symbolic power is built through the actions of green

and/or consumers' movements. For locally distinctive products, social cohesion at local level can give birth to a symbolic representation of the territory that can be externally projected⁹.

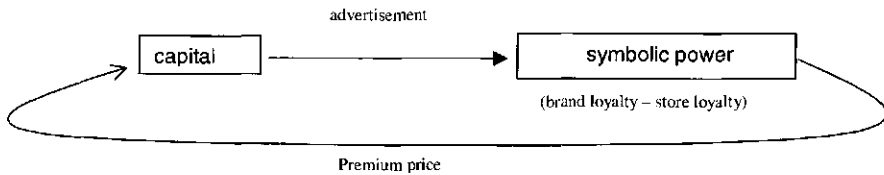


Figure 3 the economic capitalisation of symbolic power

The linkage between social movements and business opens important communication channels for alternative business, ones that are rarely available to conventional business. Alternative products are often channelled through talk shows, magazine stories, political demonstrations, comments in newspapers, etc. Moreover, because identity plays a central role in determining the attractiveness of these products 'word of mouth' becomes a very effective medium of communication.

Strategies for building hegemony: alternative networks as 'black boxes'

A successful wine route interconnects the perceptions of a territory by farmers and tourists, and the norms of behaviour necessary for its maintenance, in a coherent and purposeful way. This coherence and purpose can also be extended to elements of the built environment, such as the layout of farms and landscape structures, and to the symbolic representation, such as signposts, maps, tourist guides and product labels. Following Latour (1987) we can analyse the process of creating a wine route as the construction of a 'black box', an object of shared knowledge among a given set of actors (see figure 4). This process originates from the progressive development of a network involving human and non-human elements until its 'closure' into an 'engine': a system of relations in which all elements of the network, even if motivated by different attitudes and expectations, are 'aligned' around specific goals. Once established, a black box can be represented by specific signifiers (a name, a label, an image), which can facilitate its 'enrolment' in the creation of new networks and new 'black boxes'. For example, in Tuscany wine routes are becoming integrated with other thematic itineraries, such as those created around the valorisation of typical products¹⁰, natural areas, handicrafts and historical monuments.

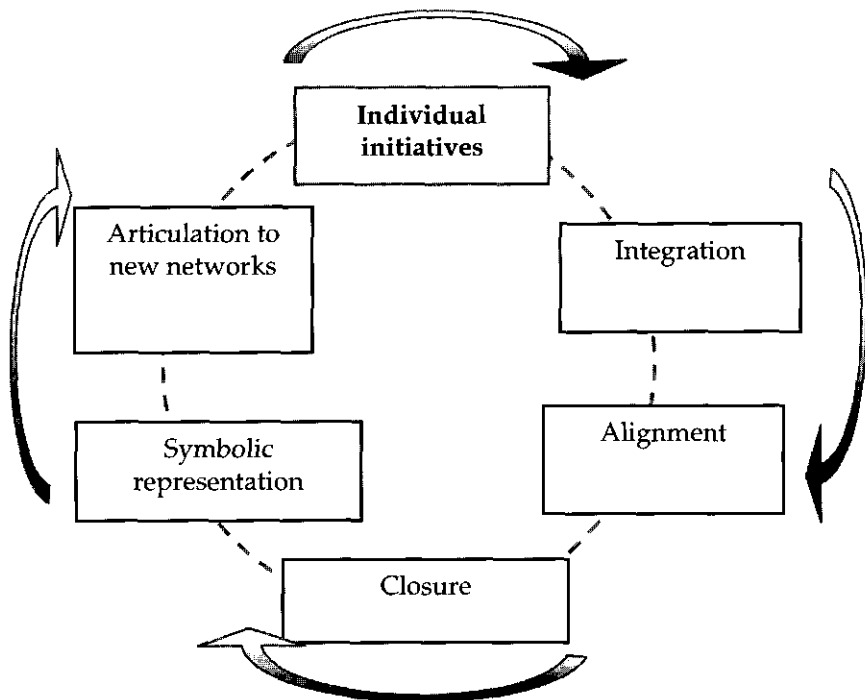


Figure 4 The process of construction of a black box (after Latour 1987)

The name *Costa degli Etruschi*, as well as its symbol, does not correspond to any official geographical entity. Nevertheless it creates a correspondence between tourists, producers and the territory, and thereby enters into the game of 'identity formation' (Castells 1998). It activates individual action and the formation of synergies. For example, it enables a local entrepreneur setting up a rural shop along the wine route to interpret the language of the territory and translate it into a basket of goods with a coherent layout and display.

Upon closer examination, the *Costa degli Etruschi* wine route itself has its roots in the articulation of other pre-existing 'black boxes' within the territory. These are for example the three PDO wines, that supplied the organisational basis for the creation of the Wine Route Consortium, and the municipal institutions, who had already activated concerted initiatives to valorise the territory. Pluri-active farms, producing quality products for direct sale, are another example, as is the common awareness of the history of the area, (as evidenced in the chosen name).

Conclusions

Wine routes are an interesting laboratory to analyse the evolution of wine regimes in Europe. As quality, diversity and immaterial aspects are increasingly important components of the wine market, new actors and organisational patterns emerge. The conventional pattern of relationships between farmers, processors, traders, is progressively changing into a dense network of local and extra-local actors, including local government, restaurants, hotels, tour operators, wine critics, wine makers, and tourists, all of whom contribute actively to shaping new trade patterns and new quality definitions.

Once wine routes are successfully established, they add value to agricultural goods and services through a 'reputation effect'. Being part of a well-known wine route is *per se* a factor of appreciation. Wine routes attract new customers to the area and generate multiplier effects. They contribute to improving the landscape, since direct contact with tourists makes farmers aware of the importance of the appearance and layout of their farms. Wine routes also stimulate a general reconfiguration of farm activities, the development of communicative and relational skills and a rearrangement of work patterns, with increased emphasis on administrative, processing and marketing tasks. In short: wine routes embody a shift from quantity to quality and from cost reduction to value adding.

Throughout the case study, we have tried to highlight the ways in which the creation of a wine route implies a progressive interconnection of human and non-human elements with symbols. Synergies are at the roots of this process, since they constitute utilitarian motivations to set up linkages with other actors. The more complex the networks are, the more these synergies can be activated. To create the context in which synergies can be activated, rural actors should be able to create hegemonic cultural codes which people can use to interpret symbols and give these meaning for action.

The example of the wine route gives important insights for public policies. These should take into account the importance of dynamic synergies and facilitate the conditions for their emergence. The same is true for the effects of black box creation on the distribution of power at local level and in local/global relations. Furthermore, the case study indicates the importance of integrating different sectoral and cultural spheres into development strategies and the need for a more coherent policy intervention by administrative bodies.

Finally, some insights can be gained in regard to international competition. We have tried to demonstrate that meeting the challenges of international competition does not necessarily imply adhering to the 'New World model' of agriculture and food production. Through appropriate institutional contexts and the selection and communication of

diversity and quality, cultural identity and quality can be preserved and enhanced and counter the pressure towards scale enlargement and standardisation.

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Notes

1 In Australia four companies dominate 80 per cent of the wine market, in the USA the five biggest have 62 per cent of the market (The Economist 1999)

2 G. Brunori, A. Rossi, M. Rovai (2000) 'Wine maker o enologo territoriale?' Paper presented at the International conference on Sangiovese, Florence

3 Of all Italian provinces Livorno has the highest ratio between the length of its coastline (290 km) and total surface area (1.212 km²).

4 Apart from its chairman (the Marchese Nicolò Incisa Della Rocchetta), the administrative board of the Consortium is composed of: a representative of the local bodies; a representative of the Chamber of Commerce; six farmers including at least one from each DOC area; a representative of reception and catering; and a representative of enogastronomy and consumer associations.

5 While wine production for this district is a traditional activity, the evolution towards quality production is a relatively recent phenomenon. In the early 1960s the Marchese Incisa introduced Cabernet vines into the Della Gherardesca lands of a noble Tuscan family and aged the wine in 'barriques' (barrels). The final result was *Sassicaia*, one of the most renowned wines in the world. This first experience paved the way for other farms and at present some 20 entrepreneurs produce quality wine of high standard.

6 The 60 vine-cultivating members of the Consortium represent 30 per cent of the farms in the vine register, but 90 per cent of the farms that produce medium to high quality wines.

7 In 1999 over 700,000 people visited around 700 wine farms in Italy through the initiative, implying an increase of 10 per cent on previous years. This confirms the enormous potentiality of this type of tourism. Data for the *Costa degli Etruschi* wine route show an increase in visitors of 20 per cent, including a high proportion of young people.

8 Changes in the values of the variables were done in pairs (price-production, price-selling, production-selling) according to two scenarios. For the 'prudential' scenario a price increase of 5 per cent, an increase in total volume of produced wine of 60 per cent, a ratio between bottled and unbottled wine of 40:60 and a ratio between direct sale and wholesale of 40:60 were assumed. An 'optimistic' scenario assumed a price increase of 10 per cent and a ratio between bottled and unbottled wine of 60:40.

9 As identities are not based on close and well defined cultural systems, and as there is not strict coherence between cultures and territory, conflict may arise on what to represent to the outside: what should the boundaries of the territory be? Who should be included and who should be excluded?

10 The Province of Lucca published a guide where the wine route of the hills of Lucca and Montecarlo intersects with those of oil and spelt. Spelt, a traditional cereal, is now regaining popularity after having been marginalised for years to the occasional use in local dishes.

13 Reflecting on Novelty Production and Niche Management in Agriculture

Dirk Roep and Johannes S.C. Wiskerke

Introduction

Since the early 1990s, we have witnessed a comprehensive and far reaching transformation of agriculture throughout Europe. It has gained its momentum as a counter-force to the sometimes disastrous side effects of an over-modernised agriculture and over-industrialised food supply chain. This is not only happening in marginalised areas, unsuitable for modern industrialised agriculture, but also, if not more so, in the most successful growth poles of modernisation, such as the Netherlands. This drive for a radical turn can be understood as a quest to once again rebalance agriculture with societal needs. Although the need for a radical turn has become more or less commonly accepted, the route to follow is still subject to dispute. There are many different interests at stake and many threats to vested positions. So we find ourselves in a difficult transition from a specific way of ordering, with its evolving socio-material order, to another; in other words, from the socio-technical regime (see Moors *et al.* in this volume) connected with modernisation, that has been dominant for several decades, to an alternative regime. This alternative mode of ordering (Law 1994) has to be built up from scratch by experimenting with promising ideas that will bring forth all kinds of working bits and pieces (novelties). In turn these have to be welded together into a properly *working whole* (Roep 2000). The new regime is shaped when moving along the track. This is a recursive process, with feed backs, feed forwards, set backs and inevitable detours. Success and failure go hand in hand, depending on ones perspective and may change over the course of time.

Radical innovation, in contrast to incremental innovation, implies a rupture with the widely shared and self-evident ideas and routines and with the vested ways of thinking and doing. When the logic of the vested order is challenged and turned upside down, the process of innovation creates instability and disorder. This then requires a common and convincing *guiding principle* that can show the promise inherent within

this dramatic process and provide sufficient *room for innovation* within the vested order.

During recent years several models or guiding principles have been proposed to address the unsustainable character of modern agriculture. According to Marsden (2003) three different models can be distinguished, which are currently competing in shaping agriculture and rural space:

- 1 The *agro-industrial model*: an accelerated modernisation, industrialisation and globalisation of standardised food production characterised by high levels of production, long food supply chains, decreasing value of primary production and economies of scale.
- 2 The *post-productivist model*: the countryside as a consumption space characterised by the marginalisation of agriculture (due to its low share in Gross National Production), the provision of private and public rural services and the protection of rural nature and landscape as a consumption good to be exploited by the urban population.
- 3 The *sustainable rural development model*: the integration of agriculture, nature, landscape, tourism and private and public rural services, characterised by re-embedded short food supply chains, multifunctional agriculture, rural livelihoods, new institutional arrangements and economies of scope.

The theoretical and empirical essays in this volume are based on the premises of the rural development model. Their central point of departure is that the problems created by modernisation, i.e. through disconnection, have to be countered by a *(re)particularisation of agriculture* (Roep 2000), i.e. reconnecting it again to its social and (agro-) ecological environment. This has also been conceptualised as the principle of downgrading (see van der Ploeg *et al.* in this volume).

The second and third parts of this volume (chapters 5 to 12) demonstrate that innovative farmers and farmers' collectives (in collaboration with other stakeholders) have produced an impressive range of promising novelties. However, many of these novelties remain hidden or are at least not generally acknowledged (by the vested order) as relevant building blocks for a transition towards sustainability.

This raises two questions. First, why do these novelties remain hidden? And second, how to uncover these promising, but still hidden, novelties and enhance their diffusion in order to facilitate a transition towards sustainable rural development? Before addressing these questions we will briefly reflect on the process of agricultural modernisation. Second, we will discuss the specificities of agriculture in relation to novelty creation and strategic niche management. Next we will briefly outline some of the lessons learned for novelty creation and strategic niche management in agriculture. We conclude this epilogue by discussing a pro-active framework for studying and managing radical innovation processes in agriculture.

On institutionalised capacity and incapacity: an institutionalisation perspective on agricultural modernisation

Producing and marketing food products of basic quality at competing consumer prices (i.e. bulk production) has been the main ordering principle guiding agricultural and rural development in all EU member states (and also in many other countries) for several decades. In primary agriculture this was translated into increasing the production per animal, per hectare and per labour unit. This drive towards maximisation of productivity has been realised through specialisation, intensification and scale enlargement.

The construction and reproduction of this track was, to a large extent, realised and facilitated through government policies. By adjusting the working of the market on the one hand and directing the supply of new production-techniques on the other a specific distribution of opportunities and restrictions was arranged, thereby creating a selective space for manoeuvre for farming, in which only modernised farms were expected to survive (van der Ploeg 1987; Roep 2000; Wiskerke 1997).

Through alignment and co-ordination the modernisation project gradually got more momentum¹ and the capacity to have the complex whole work effectively, from the cell of a plant to the European Community, grew. This capacity is very specific and became solidified through a nearly endless, varied and heterogeneous series of socio-material phenomena: specific policy instruments, specific knowledge and skills brought forth by specific research programmes, specific animal and plant breeds obtained through improvement, specific farm machinery, specific buildings, a specific production environment created through large scale reconstruction of the countryside, an extension service equipped to spread a specific message, the promotion of specific interests by co-evolved interest groups, a specific organisation for processing and selling of a range of specific products, a specific report between the family and farm business and between the family farm and environment, etcetera. This *institutionalised capacity* (Roep 2000) in turn works as a pre-ordered reality for the actions of engaged persons, providing a limited institutionalised space of action of opportunities and restrictions, or a selective institutional environment. Modernising thus became taken for granted, an institutionalised practice based on a widely shared and objectified range of ideas on how to think, feel and do. It came to define how things should be done and became seen as inevitable. That is why the translation of *the* working of the market and *the* progress made in (production) technology into *the* optimal order was called rationalisation.

Primary agriculture became embedded in an *organisational-institutional environment* with the characteristics of a quasi-organisation, where people were committed to their destined role and tasks: the co-realisation of a

modern way of producing and marketing on rational grounds. Benvenuti (1982) has incisively interpreted this orderly whole as a Technological-Administrative Task Environment (TATE) because of its strong prescriptive impact on the style of farming (see also Ventura and Milone in this volume). The working of the market as well as progression in technology were considered as autonomous and linear processes and therefore acquired a strong notion of inevitability. The unavoidable future was then predicted through the extrapolation of these autonomous and linear processes. This was often done with great eagerness and firmness. From the projected junction of both processes a picture of optimal farming in the future could be derived. This was in turn translated into what was perceived as an optimal complementary socio-material environment. Practice was then measured according to this virtual optimal farm in a virtual environment (van der Ploeg 2003). This implied an agenda (van Lente 1993): what had to be done to realise this. This rang the bell for the next round in the reordering of agriculture and the countryside. Farmers and farms were classified in terms of modern versus traditional, vanguards versus laggards, farms with and farms without future perspectives (van der Ploeg 1987). This distinction further legitimated the selective use of resources in policy. Through a specific (re)distribution of restraints and opportunities the limited space for action was even further restricted (see e.g. de Bruin 1997). Future explorations of promising technological progress were converted into a demand for that technology, resulting in a promise-requirement cycle (van Lente and Rip 1998). The obvious and inevitable was thus realised, like a *self-fulfilling-prophecy* (van der Ploeg 1995). This process repeated and re-enforced itself and propelling a seemingly autonomous process whose expression lay in the gradual outbuilding of capacity along a *narrowly demarcated technological trajectory* (Roep 2000; see also Moors *et al.* and Ventura and Milone in this volume). The capacity that was built was impressive, but the dynamics of this trajectory also had the features of a treadmill, of machinery out of control and almost impossible to step off of.

To unravel the working of this whole in all its parts is an enormous job. Here we restrict ourselves to one specific angle: the essence and impact of the *institutionalised capacity*. As we argue, the essence of modernisation was the generalisation of a specific way of farming intended to maximise productivity. All kinds of local socio-material characteristics, e.g. different agro-ecosystems such as peat land areas or hedge rows, were seen as obstacles to be overcome or to be eliminated. Particular agro-ecosystems had to be reconstructed materially as well socially to meet generalised optimal standards: creating optimal production conditions for optimal farm management. This *disconnection* of farming from the historical

particular socio-material environment is inherent to the modernisation project (van der Ploeg 2003; Roep 2000)

The modernisation project did not come out of the blue, nor was it implemented in a socio-material vacuum. It originated from a pluriform society², from a mosaic of interacting differential modes of ordering or styles. The intention was to re-model this according to modern standards and to rationalise it. This was always a matter of interaction, exchange and mutual influencing; of interlocking innumerable projects (Long and van der Ploeg 1994). Retrospectively one can conclude that the modernisation project gathered sufficient momentum to enforce a radical re-ordering of the existing socio-material whole. In other words, the agricultural modernisation project – in particular the keyword ‘structural development’ – became, in the course of time, institutionalised. Institutionalisation is, according to Zijderveld (2000: 31-32),

‘the historical process in which initially individual and subjective behaviour (the unity of acting, thinking and feeling) is imitated, and then repeated in time to such an extent that it develops into a collective and objective pattern of behaviour, which in its turn exerts a stimulating and controlling influence on subsequent individual and subjective actions, thoughts and feelings. This creates taken-for-granted routines that may clear the way for the design of new actions, thoughts and feelings, if, that is, these routines do not fossilise into stifling expressions of traditionalism’.

Institutionalisation is thus a historical process in which individual and subjectively experienced behaviour is objectified into behaviour patterns, which are, as it were, detached from the individual concerned. What began as a choice to achieve policy goals (i.e. safeguarding domestic food supply, contribution of agriculture to the growth of domestic prosperity and a good living for those working in agriculture) became a self-evident development trajectory. Modernisation was transformed from a choice for a specific development route into a development route that was no longer questioned and subsequently one that went without saying (i.e. an objectified fact). Once institutionalised, the modernisation project legitimised the structural development measures designed to achieve the goals that it had defined. Legitimation, according to Berger and Luckmann (1967: 111),

‘justifies the institutional order by giving a normative dignity to its practical imperatives’.

The inevitable modernisation of agriculture also de-legitimised alternative options, routes and policy objectives: alternatives were classified as unacceptable because they were at odds with the self-evident.

But, as remarked before, the success story of agricultural modernisation also had a downside. Not everything went that smoothly and according to expectations. The radical reordering of agriculture and countryside ran

up against resistance from nature as well society. This expressed itself in all kinds of unforeseen social and material side effects that were under-appreciated or not appreciated at all. For example: a decline in natural values and a deterioration of valuable (cultural) landscapes, structural surplus production and rising public costs of market interventions, increasing environmental pollution connected to the intensification of land use, lagging family farm incomes, marginalisation of disadvantaged regions, emerging problems with animal welfare related to the maximisation of productivity. The impact of these undesirable side effects grew alongside the capacity built along the, once promising, modernisation trajectory. This triggered a counter-offensive, i.e. a process of subjectification as a reaction to a preceding objectification, as part of a cyclical, repeating fundamental anthropological process (Zijderveld 1974).

For various reasons societal opposition to the negative side effects of modernisation increased and ultimately the legitimacy of the modernisation project was seriously questioned. Not that the modernisation project had never been controversial, on the contrary. It has always been criticised from different angles and, at times, has been the subject of violent opposition by farmers. But the more effective that modernisation became, the more tangible the side effects became and the more criticism rose. The taken-for-granted nature of the project, and the notions of autonomy and inevitability that went along with it, were fundamentally questioned. A swelling counter-movement slowly but surely undermined the legitimacy of the project. At the same time a gradually growing number of farmers were looking for a way out to avoid what was supposed to be inevitable: i.e. either to continue along the track of increasing productivity, specialisation and scale-enlargement or to quit farming. This contained the seeds for change: ideas that look for a transformation of the vested order. But this couldn't occur without a struggle. The counter-offensive needed more momentum and, for that reason, more allies. In order to germinate and reach maturity potentially innovative ideas need fertile soil. They need to be nursed and protected against the vested order. This pioneering requires the institutionalisation of a tailored, selective and, protected space; an *institutionalised innovative space* where the necessary knowledge and skills can be built up. Studies of farming styles (see e.g. van der Ploeg & Long 1994) revealed that farmers were exploring new ways and that they were supported by new allies. In words and actions these farmers opposed prolonged modernisation. Studies of farming studies and follow up research on innovative farmers' collectives (see e.g. van der Ploeg and van Dijk 1995) show how these pioneers turned away from the vested order and managed to create some innovative space on their farms in order to counter modernisation. In doing so they tried to extend this capability, creating more institutional

space for a different way of farming and extending it through new arrangements with the support of new allies. But these challenging and promising initiatives still lacked the maturity and momentum to become a real alternative to modernisation. They were still too fragmented, too isolated, too fragile and vulnerable within the current institutional settings. To grow into mature, self-evident, institutionalised ways of farming the modernisation project itself had to be stopped and dismantled to give way to a radical institutional innovation.

With this emerging new trajectory came the notion of *institutionalised incapacity* as the reverse side of the institutionalised capacity built up during modernisation: the astonishing incapacity of the vested order to let things work out differently, which went far beyond unwillingness or obstruction. Where problems due to over-modernisation asked for new answers, the techno-institutional environment of agriculture followed the same old pattern. This incapacity was very evident when innovative groups of farmers in several regions addressed specific questions on how to re-particularise farming (see e.g. Roep 2000; Wiskerke 1997; Wiskerke *et al.* 2003): i.e. how to readjust farming again to specific agro-ecosystems, or how to commercialise the particular natural and cultural values by means of regional typical products. This move to a *(re)particularisation of farming*, countering the impact of modernisation, demonstrated the almost total absence of specific knowledge and skills, and the unwillingness of the vested order to countenance a radical change (van der Ploeg 2003).

This brings us to a more general remark: building the capacity to have a whole work specifically also implies a (latent) incapacity to have the whole work differently. The narrower the chosen trajectory, the more effective but also more one-sided the institutionalised capacity will be and the more evident the level of institutionalised incapacity will become. In the nineties this clearly was the case for many EU member states regarding agriculture and the countryside. The modernisation project was able to have such an impact because it was so very selective, one sided and rather simplistic in its goals. Surrounded by notions of obviousness, autonomy and inevitability the modernisation trajectory was pursued more or less blindly. Every deviation from this straight forward course would, according to vested opinions, only lead to detours and a loss of scarce time and resources. Of course, all kind of obstacles would appear, but the general belief was that they could be overcome through technological means.

Even when the call for a different way of producing and marketing food attracted more response from society, modernisation continued to be carried and propelled by the vested order. The gap between productivist agriculture and societal needs widened. The need for radical change was

first acknowledged by major parts of the vested order in the course of the nineties, after a succession of food and animal disease scandals had severely undermined consumers' trust and important markets collapsed: societal needs had to be met, consumers' trust and legitimacy restored.

Novelty creation, SNM and the locus and focus of farming

To enhance the development and diffusion of promising novelties Moors *et al.* (this volume) propose the construction of desirable transition paths through the strategic management of niches. Strategic Niche Management (SNM) is proposed as a tool for simultaneously managing both technical and institutional change and smoothing the diffusion process of promising novelties. The knowledge and expertise of users and other actors, such as policy-makers, researchers or representatives of public interests, are brought into the technology development process, in a process conceptualised as *smart experimentation*.

SNM was initially developed by the 'Twente school' in science, technology and society (STS) studies (Hoogma 2000; Hoogma *et al.* 2002; Kemp *et al.* 1998, 2001; Rip & Kemp, 1998). Initially it was a tool for nurturing promising technologies in transport to enhance the rate of application by making them more robust and by building a complementary institutional setting in which they can function properly. Later, it became part of a broader framework: the construction of new technological regimes and the possibility of intentionally working towards desired regime change. In this volume the focus is on agriculture and rural development which, in our view, differs substantially from domains such as transport or energy. Differences in the nature of farming imply both empirical and theoretical differences with respect to novelty creation and SNM.

The first difference regards the specificity of the *locus* and *focus* of farming. Agriculture can be seen as a specific form of co-production, as the result of all kinds of interacting ordering processes with different socio-material effects in time and space (Roep 2000). One specific feature of farming is that it involves the transformation of dead and, more specifically, of living matter. Additionally, because farming is located in an agro-ecological environment, it is an open system, so is subject to all kind of uncontrolled processes, which make it rather unpredictable. Although agro-technological development has attempted to minimise these characteristics, farming still depends, albeit to different degrees, on the working of uncontrolled 'natural' processes and therefore on farmers' knowledge of how things work locally (Stuiver *et al.* this volume). If one adds to this the different cultural and politico-economical circumstances farming is subjected to, and the relative small-scale (mostly family) business structure, one can understand the striking diversity in farming. Evidently, this has implications for knowledge development and

innovation, which should be based on diversity rather than seeking to overcome and destroy it.

A second, related difference regards the *locus* and nature of novelty creation. In (hi-tech) industrial sectors novelty creation is located mainly within specialised, capital intensive and isolated research and development (R&D) centres. The R&D scene is dominated by a few industrial conglomerates. Agriculture, however, consists of a multitude of relatively small-scale (mostly family) enterprises. There have always been innovative, leading farmers but, in general, a lack of resources and co-ordination has hampered innovation and diffusion. From the early 19th century onwards a publicly funded system for applied research, education and extension was developed to enhance the application of novel, more productive, farming practices. Until World War II this R&D body interacted strongly with innovative farmers. Innovation in agriculture was mainly founded on novelties created and/or tested by farmers. R&D was rooted in and sustained diversity. This changed fundamentally in the post war era when a mono-functional, productivity perspective on agriculture became institutionalised. For this regime diversity in farming and local specificity became obstacles to overcome. The expanding R&D infrastructure became the *locus* of novelty creation and innovation. Novelties created by farmers became irrelevant and subsequently were unnoticed. Nowadays, with modern agriculture in crisis, a re-particularisation of farming and subsequently a re-grounding of innovation in diversity and novelty creation by farmers could prove to be a promising solution for sustainable agricultural development. However, this promise implies debates, controversies, conflicts and even struggles with the vested institutional order. This explains why creating and maintaining room for novelty creation and smart experimentation by farmers is such an important element in the strategic management of promising niches.

Lessons learned for SNM in agriculture

In the second chapter of this volume Moors *et al.*, following Hoogma (2000), state that the success of early niche development depends on the quality of learning and the quality of institutional embedding. Geels & Kemp (2000) argue along similar lines that successful niche development and management depend on the quality of the processes that shape niche development:

- 1 The development and alignment of strategies and expectations;
- 2 Learning processes;
- 3 The creation and stabilisation of a social network.

Looking at the different cases discussed in this volume, i.e. different examples of agricultural niches, we can conclude that learning and institutional embedding (or more specifically alignment of expectations

and the creation of a social network) are indeed key factors to understand the (relative) success and failure of radical innovations. However, the different cases discussed also point to some specific lessons that are important for successful niche development and management in agriculture. We will briefly outline these lessons.

1 Create and maintain a learning environment

The different cases discussed in this volume show that learning is a multi-dimensional process. First of all it requires learning about the effectiveness, or performance, of a novelty for achieving a specific goal. Second, a learning environment should facilitate double-loop learning processes (Hoogma 2000): i.e., learning about the assumptions, meanings and preferences that relevant actors have (and develop) during the process of novelty creation. Third, it is important to learn about organisation, network building (i.e., the enrolment of others) and niche management as well as about the complex interaction between the technical and institutional aspects of novelty creation.

2 Explore and understand diversity

It is of crucial importance to explore and attempt to understand the relevant diversity. This is a critical success factor, especially in the initial stages. Reference to previously hidden novelties ('deviations from the routine'), shows that these are real phenomena that are being discussed, as opposed to mere plans or intentions. Of course, the capacity to present these initial deviations (or hidden novelties) as solid and as promising becomes, in this respect, decisive just as, further on in the process of SNM, the capacity to further unfold these novelties into a convincing and well-functioning programme is a central requirement. This is clearly illustrated by the case of the VEL and VANLA environmental co-operatives (see Stuiver and Wiskerke, Reijs *et al.* and Sonneveld *et al.* in this volume). The further unfolding of novelties implies a process of (re-)design affecting both the technical and the institutional aspects. Levels of performance are improved and objectified (made visible and scientifically founded), both to the farmers involved and to the outside world.

3 Make new and effective connections

At the heart of this process of (re-)design there is a simple but powerful 'triangle' of farmers, surrounding actors (other rural entrepreneurs, researchers, extensionists, farmers' unions, etc.) and the endogenous development potential required in the local constellation (the promises resulting from the local 'deviations from the routines'). In the end (re-)design is about making new and effective connections (see Mango and Hebinck in this volume) and creating coherence and synergy (see Brunori *et al.* in this volume). These examples show the importance of the basic

'triangle', which places local practices and resources as a starting point for further processes of unfolding.

4 Creating alignment is a continuous process

The alignment of strategies and expectations is not a finite, linear converging process. Full alignment will probably never occur, and if so, only temporarily. Continuous re-alignment at later stages is thus as important as alignment during the initial phase. As with actors' expectations and strategies, the stability of a niche is, or can be, of a temporary nature (see e.g. Wiskerke and Oerlemans in this volume). Continuous management and evaluation of the niche and its surrounding network, aimed at maintaining individual responsibility for, and commitment to, the collective goals, approach and products, remains an important activity. It is therefore important to stay in control and avoid a kind of expropriation of the (re-)design process.

5 Improve ones own situation and prospects

A fifth and perhaps self-evident lesson is that the actors are involved because of the prospect of improving their own situation and prospects. If there is no progress or reciprocity (at the level of either the material and the moral economy) then every attempt at successful niche management will fail. This evidently applies to all parties involved.

6 Change agents are crucial to set a process in motion

Visionaries are needed to make the connection between societal developments at the broad landscape-level (see Figure 1), putting pressure on the dominant regime, and creating room for manoeuvre at the local-level. Their role is to envision windows of opportunity, express expectations and enrol alliances. The cases discussed in this volume have taught us that in agriculture local leaders (not necessarily farmers) can play an important role as visionaries or change agents.

7 Assess the value of the unexpected

The case of the *Quesería Morisca* (Remmers in this volume) demonstrates that the success of a novel socio-technical configuration may depend on the capacity of the people involved to transform the unexpected or unintended into something useful or valuable. This implies that results of experiments should be assessed only according to initial expectations and promises. Evidently this also has implications for the organisation of learning processes, i.e. the quality of learning processes also depends on the capacity to make use of, and build innovations upon, unexpected outcomes.

A revised framework for studying and managing technical-institutional change

Based on the contributions to this volume we have developed a more proactive framework for studying and managing the co-evolution of technical and institutional change (Figure 1). It is an elaboration of the work on technical change and transitions carried out by Kemp *et al.* (2001; see also Figure 1 in Moors *et al.* in this volume) and Geels (2002). The institutionalisation perspective (i.e., the routinisation and socio-material sedimentation of practices) and the interaction between the material, technical and social components of technical-institutional change is made more explicit in the vertical dimension. This dimension is to be understood in terms of expanding socio-material spaces; going from local practices (where the actors are) to the wider world. The dynamics along this spatial dimension can be studied in terms of actor-worlds.

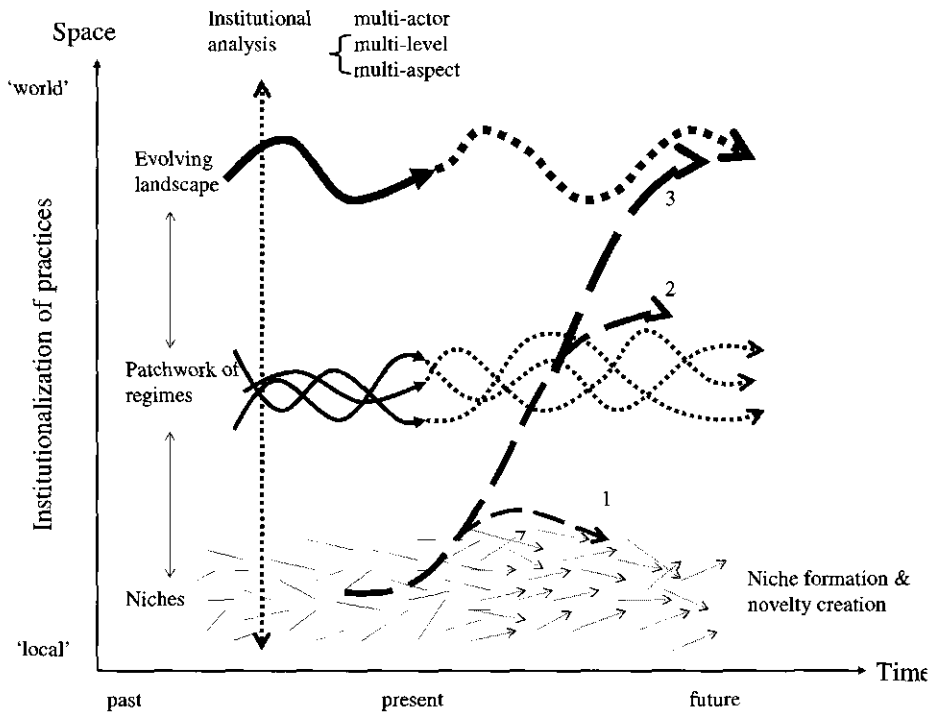


Figure 1. An overall framework for studying and managing technical-institutional design (1 = No breakthrough of novelties; 2 = System innovation and regime shift; 3 = Transition). After Roep (2002).

The framework can be used as an analytical tool to study and comprehend the complexity (multi-actor, multi-level, multi-aspect) of technical-institutional change. However, it can also be used as a reflexive

tool in order to question oneself: how far has a transition in agriculture come and what can we do about it? By way of conclusion we will do the latter and will make some remarks on how to relate novelty creation, (system) innovation and transition as inputs for a pro-active management of technical-institutional design processes:

- 1 The transition in agriculture is still in the early phase of development and, although we can see the emergence of a new regime and the contours of a system innovation in the different niches described in this volume, a reversal of regimes is still a long way off. As the modernisation regime has been a strongly dominant force for some decades, innovation and transition in agriculture are seriously hampered by the institutionalised incapacity to do things differently (Roep 2000). This (consciously or not) obstructs novelty creation and consequently system innovation and, in the long run, a transition towards the sustainable development of agriculture and the countryside. Institutional innovation (as part of a reversal of regimes), exploring new ways of doing and new ways of formal organisation, is crucial for the transition in agriculture to take off.
- 2 No matter how much we talk or write about it, (system) innovation and transition are started by piecemeal changes that are locally produced, by novelties created by innovative actors which need to be nurtured in niches to develop their potentialities. In pro-active terms this means that innovation and transition are inevitably rooted in promising, innovative practices. This implies that we need to stimulate novelty creation, niche building, smart experimentation and the creation of communities of practice (building social capital) in order to explore and evaluate the potential of (a connected range of) novelties. Such potential needs to be evaluated at different levels, e.g. at the level of the farm, sector, region and society at large, as considerations of sustainability will differ between these levels, and this will influence design criteria. Taking into account the specificity of agriculture it is important to base system innovation and transition upon the innovative work of farmers.
- 3 Innovation or transition policy is more effective at the start or take-off of a transition, when things are still fluid and relatively open, than in the later stages of transition (Rotmans *et al.* 2000). Policy needs to stimulate and facilitate novelty creation and smart experimentation, in order to learn from, and further develop, their potentialities in respect to system innovation and transition.
- 4 Innovations and transitions have to be connected to ongoing dynamics and be rooted in innovative practices. Innovations and transitions are not neutral processes: there is a lot at stake. One can explore different, competing transition paths that lead to different outcomes. The prospective outcomes, as well as the prospective transition paths

leading to these outcomes, will be subject of debate. One management or design tool, which is often used, is that of projecting different (visionary) desirable future images and then projecting possible transition paths back from this point to the present situation, identifying the obstacles to overcome and what is needed along the way (backcasting). One must however keep in mind that creating these future images and possible transition paths is merely an instrument and not a goal in itself. One cannot disregard current dynamics and enforce these, even though some force is sometimes needed to effectuate change. Top-down management of innovation and transition, focused on a single goal is not appropriate in a pluriform society, as we have learnt from the several decade long process of modernisation.

- 5 Finally we want to reiterate the importance of simultaneous design of the technical (artefacts, machines and systems) and institutional functionalities (rules, roles and procedures) of novel configurations in order to create a more properly working whole. Even if they are not aware of it, institutional and technical engineering are not entirely heterogeneous activities (Law 1994). Technical engineers presuppose or, often implicitly, design a complementary institutional setting, and institutional engineers often do the same in reverse. This emphasises the need for inter- or even trans-disciplinarity as a sound foundation for intentional technical-institutional design.

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Notes

1 'Technological systems, even after prolonged growth and consolidation, do not become autonomous: they acquire momentum. They have a mass of technical and organisational components; they possess direction, or goals; and they display a rate of growth suggesting velocity. A high level of momentum often causes observers to assume that a technological system has become autonomous... The large mass of a technological system arises especially from the organisations and people committed by various interests to the system. ...The durability of artefacts and of knowledge in a system suggests the notion of trajectory, a physical metaphor similar to momentum.' Hughes (1987: 76). 'Momentum, however, remains a more useful concept than autonomy. Momentum does not contradict the doctrine of social construction of technology, and it does not support the erroneous belief in technological determinism. The metaphor encompasses both structural factors and contingent events.' (*ibid.*: 80).

2: The more far reaching society becomes, the more pluriform it will be (Berger and Luckman 1966; Zijderveld 1974). Several modes of ordering will co-exist, as distinguishable styles with differential socio-material effects. The interplay of these different modes of ordering actually shape society. If a society is stretching out in time and space, where most members have no direct interpersonal contacts, a common styling in the way certain things have to be done becomes crucial for effective co-ordination and social cohesion. Mapping the differences and similarities, the interplay, the construction and destruction of a vested order: all this belongs within the classic repertoire of empirical sociological research.