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Evaluation of Early Processes in System Innovation

A Pilot Study on the Transformation of Dutch Agriculture and Food Chain to Sustainability

A. Faber, G.A. Rood, J.P.M. Ros
RIVM Netherlands Environmental Assessment Agency, Bilthoven, The Netherlands

1. The evaluation of system innovations for sustainable development

Despite many success stories in environmental policy, several quite persistent environmental problems remain, such as increasing CO_2 emissions, loss of biodiversity, the disturbance of the nitrogen cycle and excess noise in our daily surroundings. These persistent problems have appeared to be much harder to tackle with traditional environmental policies. The Dutch government has introduced a new long-term strategy to deal with these problems in its Fourth National Environmental Action Plan: *transition management* or the management of system innovations as a policy tool (VROM, 2001). This policy requires an integrated control of large scale institutional and technical changes within a context of uncertainty and complexity.

Such a policy implies a focus on the process of (the preparation of) system innovations, rather than strictly on the goals to be reached. A policy of system innovations distinguishes what should be done on the short-term in order to reach goals on the long-term. Management of system innovations does not necessarily mean that the national government plays the classic hierarchical role of controller. In order to be able to involve other actors in a society it may well be a fruitful strategy for a government to act as a facilitator or sometimes a director rather than as an enforcer of new rules. Transition management aims to provide the new policy instruments to deal with the persistent environmental problems.

A new policy instrument requires new methods for the monitoring and the evaluation of the effectiveness and the efficiency of this instrument. The shift in policy from a target approach to a system management perspective renders simple measurements obsolete. Gathering physical data and measuring straightforward developments does not suffice anymore. The monitoring of system innovations in society needs to involve social processes, to which many actors, institutions and innovations may play a role. Therefore, it is necessary to involve new parameters such as intentions, actions taken, networking, research and development, first movers and resistance against changes.

In this chapter we present some methodological elements of this new type of monitoring. The transition to a sustainable Dutch agriculture (and food chain) is one of the main targets in national environmental policy. This case is usded here to illustrate our approach.

2. General notions on the management of system innovations

Transitions or system innovations are often related to large-scale technological regime changes. In a fairly new context this concept is extended to large-scale changes in society as well. This extension allows for a more integrated analysis, as well as for policies that go beyond the traditional straight causal lines. System innovations as we will use it (i.e. as a socio-technical concept) can be defined as "a gradual, continuous process of structural change within a society of culture" (Rotmans et al, 2001). This same study states that "transitions involve a range of possible development paths, whose direction, scale and speed government policy can influence, but never entirely control."

An important notion on system innovations is the idea that they usually take the shape of an S-curve, that starts off from a take off-phase, through an acceleration phase and to a new stabilisation of the system. Many different smaller dynamics shape this main path to stabilisation, but they do not all by themselves take the required direction. Transition management is to a large extent the modulation of all the smaller dynamics in society in the same and preferred direction. In order to do so, it entails at least the following important features:

- *Goal setting:* It is important to have a certain focus, to be able to give direction to the smaller scale dynamics and innovations. Goal setting is necessary, but goals are not necessarily fixed.
- *Type of management* is transformed from hierarchical towards network management, which takes all relevant actors into account. This feature originates from the notion that direct steering of the large changes implied is not possible, and that the transition manager should focus on providing the framework and guidance to the other actors involved. Noteworthy is that some of the classic policy instruments are still available here, e.g. subsidies, taxation or regulations.
- Some changes involve necessary (technological) pathways afterwards, hence creating a 'lock in'. *Uncertainties* and the management of *lock-in* have to be incorporated in transition management.[1]
- Short-term policies should be placed in a *long-term context*. This has already been applied in several policy fields – such as e.g. present-day climate change policy – but it is not always clear to policy makers what the short term policy consequences are of setting long term goals. Transition management should take this more into account.
- System innovations not only go through different time phases, but also take place at different *scale levels*. The micro level involves individuals, the meso level networks, organisations and institutes, the macro level conglomerates, nations and the wider institutional context. These levels can be taken collectively to form the socio-technical landscape (Geels and Kemp, 2000; Geels, 2002). Policies should take the appropriate scale into account.

The management of system innovations covers a wide range of areas for focus of attention, from problem perception to the actual realisation of large scale changes.

1 See (among many others) e.g. Dosi (1982), Nelson (1988), Nelson and Winter (1977) on the Schumpeterian concept of lock-in.

Many publications have come forth dealing with the relevant aspects of system innovations and their management (see, for example, Boulding, 1970; Rotmans et al, 2000; Geels and Kemp, 2000; Rotmans et al, 2002; Butter, 2002; Molendijk et al, 2002; Geels, 2002; Spakman et al, 2002). Many of the recent conceptual contributions have originated in The Netherlands, no doubt promoted by the policy makers that have put the concept in practice.

In our own contributions to the system innovation concept, we have concentrated on the development of an evaluation methodology for transition management (see Spakman et al, 2002; Rood et al, 2002; Van Wijk and Rood, 2002; Ros et al, 2003). This methodology will be elaborated further in the following chapters.

3. Methodology for the evaluation of system innovations

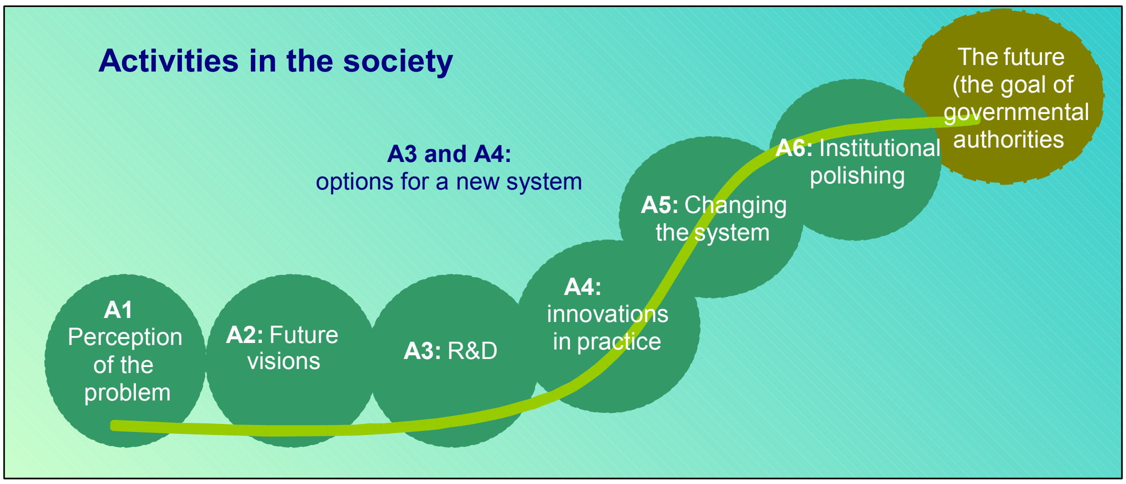
3.1. The methodology of evaluation

We have developed a framework called 'arenas in the transition process' for the evaluation of controlled system innovations. An 'arena' in the framework is defined as a 'set of activities with the relevant actors involved'. These arenas cohere with the process of system innovations along the theoretical S-curve, so as to basically provide an analytical framework to assess the activities carried out by the many actors at the various stages of the system innovation. We distinguish the following six arenas (see figure 1):

Arena 1 Problem perception;
Arena 2 Development of future visions;
Arena 3 Research and development;
Arena 4 Pilot projects and first movers;
Arena 5 System changes;
Arena 6 Final institutional polishing of the innovated system.

Noteworthy here is that the arenas are interrelated, not only in a serial, but also in a parallel process. To carry out a proper evaluation of the activities in each arena, we need to introduce a certain measure or indicator for these activities for each of the arenas. This quantification enables us to monitor progress in the system innovation at a later stage, but first and foremost it allows us to make a baseline evaluation.

Figure 1: Framework showing the 'Arenas in the transition process'



3.2. Elaboration of the six Arenas

A1 perception

This Arena shows the level of agreement on (the seriousness of) the problems. Here already some initial priorities are set with respect to solutions and options for action. The perception is based on a broad array of sources, such as scientific knowledge, calamities and the sacrifices anyone will have to make in order to accomplish potential solutions. The perception is often fed by the physical monitoring, but uncertainties are an important source of controversy at this stage.

A2 Development of future visions

Future visions are important to stimulate actors to overcome barriers on the way to reach a solution of the perceived problem. It is important to reach some agreement on explicit goals, as this will give direction to later developments of technologies and institutions. On the other hand, too much detail could hamper the actors in reaching agreement to the point that it could discourage relevant players by frustrating their creativity. This suggests finding an optimum between explicitness and level of guidance. Such an optimum depends on the state of the developments in the other arenas; making strides to the optimum spurs on the players involved, giving them a certain 'push' in the attempt to move into subsequent arenas.

A3 Research and development

A system innovation needs new technical options. Surveying the breakthrough chances for technologies will involve at least some insight in technological development, market structure and market chances, along with political backing. Such an assessment is therefore not only based on the characteristics of the technology itself, but also on the institutional environment. Innovation involves indicators such as R&D budgets, governmental support, competitiveness, synergy between researchers and potential users (see eg. Shapiro, 2002). It is key to develop a network of innovations, in order to improve interactions and hence gain momentum.

A4 Pilot projects and first movers

'First movers' are players able to combine conscience with the nerve to experiment (Rogers, 1962). They are usually the actors that are willing to take some risks and consequently will be found at the start of the diffusion process of any new innovation. Even before these initial processes of diffusion take place, pilot projects will be started to test and improve the new technologies. These experimental projects can be monitored. To evaluate whether first movers have taken their position, setting the stage for follow-up by the early majority, we can distinguish upcoming niche markets in agriculture and assess their potential and contribution to the sustainability trajectory.

A5 Changing the system

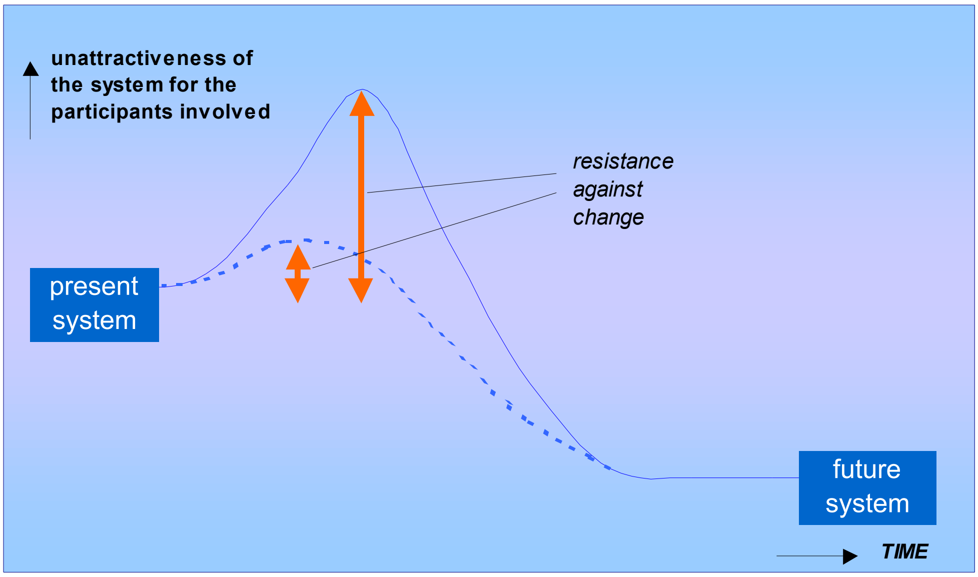
A key challenge in the process of system innovation is to overcome high barrier of resistance, that occur between the present and the future systems (see figure 2). This argument bears much resemblance to that used in the principles of thermodynamics, i.e. a 'hill of resistance' will have to be taken or a high energy input is needed in order to reach a system of high attractiveness and efficiency.

To quantify the resistance we use the so-called *MEI-model* methodology, which was developed to determine the efficiency of policy instruments (Van Wijk et al, 2001a and 2001b). The method is based on the driving forces or pressures on an actor in relation to the required targets. Such pressures could be, for example, financial impact, pressure of policy goals and social pressure. The forces and pressures are determined using a data mix of facts from various references in literature and from monitoring programmes, or from expert judgements when facts and measurements are not readily available. The separate pressures can each show either positive or negative directions.

A6 Final institutional polishing of the innovated system

The final phase of system innovation involves the institutional polishing of the new system. It is natural to include the phase of maintenance here. This arena may also include several new system participants when compared to the initial situation.

Figure 2: Resistance on the trajectory between the present system and the future system.



3.3. The framework

The arena framework as introduced allows for a closer evaluation of the underlying processes of system innovation. It does not necessarily relate to the policy goals of sustainability, but focuses on the activity of the processes in each stage of the transition. The methodology allows for the evaluation of other arenas even without first assessing these future visions. This does not mean that a transition can be organised without setting goals or elaborating future visions; this is exactly what is evaluated in the first arena. The overall assessment of a managed system innovation takes all the arenas into account.

One of the advantages of this approach is that relatively small signs of progress and activity can be identified. This framework can hence be applied at any stage of the system innovation. In the next chapter we will illustrate the application of this framework for the third and fourth arenas on the transition to sustainable agriculture. This should allow the assessment of the R&D and pilot projects phases by showing the activities of the main participants in these arenas.

4. Application of the evaluation framework

4.1. The R&D Arena on organic agriculture developments

4.1.1. Determinants of the environment for R&D investments

The third Arena of our analytical framework concerns the development and level of R&D. Research and development amalgamates a complexity of activities around the development of new technologies, often in co-evolution with institutional and organisational changes. A lot of research is done on the economic drivers behind R&D investments and technological innovation processes (e.g.: Fagerberg, 1988; Porter, 1990; Kemp, 1995; Stern et al, 2000; Shapiro, 2002; Montalvo Corral, 2002). We will not go too far into the discussion on the driving forces behind technological innovation and R&D, but limit ourselves to three main framework determinants: government policy, market structure and technological stage of development. These three framework determinants each incorporate many characteristics. Here we will briefly examine some of these characteristics.

Market structure is a rather fluid concept, but here we limit ourselves to either a competitive structure or a more co-operative structure. A competitive structure is often regarded as the best environment for a high level of R&D investments (Shapiro, 2002), even though this leads to a certain level of R&D over-expenditure (Verspagen, to be published). The competitive market structure uses firm profits as the main incentive for investing in innovations. The evolution of a co-operative market structure requires a director to organise the co-operation; the most obvious director is the government. An important indicator for the relation between innovative power and market structure is given by Porter's Index, which aggregates several indicators according to the quality of the innovative infrastructure and the quality of public research, as well as some cluster (or sector) specific indicators (Porter, 1990; Stern et al, 2000). Porter's Index is essentially aggregated in three main clusters: private research, public research, and the (institutional) links between these.

Technological development is represented by a point on the learning curve of a certain technology. This curve can be thought of as proceeding from invention to wide spread application, and usually takes the form of an S, similar to the system innovation curve we sketched earlier in this chapter. The R&D phase of a technology usually comes at a point where applications for a technology take form, hence distinguishing the phases of fundamental research and applied research. If a technology or invention is still far from application, R&D investments may still be very low.

Government policy stems from a reflection upon the role government wants to play, be it either very liberal or very market oriented. The policy determines the level of governmental interference. Basically, this interference can focus on market innovations (enhancing private R&D) or at universities and public institutes (enhancing public R&D). These options are not mutually excluding and they can be used in addition to each other.

For the purpose of evaluating Arena 3 in the transition to a sustainable agriculture, these three framework determinants can be represented collectively by a set of characteristics (see table).

Features for the R&D-lay out	**Determinants**
Technological barriers	Determine level of applicability of technology and level of private investment; they are determined by market structure (for finance) and technological development
Attention and competence	Determine level and direction of R&D investments; they are determined by policy agenda and market structure
Market position	Determines the policy agenda and level of R&D investments; is determined by market structure, government policy, technological development and position of alternative technologies

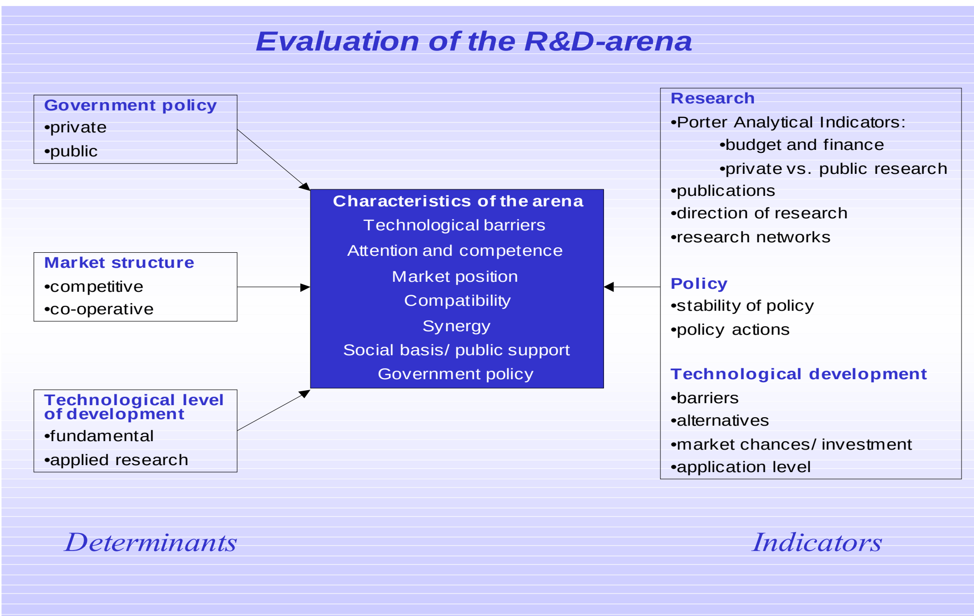
Compatibility on current technological regime	Determines whether new technology can be attached to prevailing technological regime; determined by technological development and by the position of alternative technologies
Synergy between developers and applicators	Determines whether developers and users work together proceeding from innovation to diffusion of technology; relates with level of technological development, market structure and government policy
Social basis / public support	Determines whether technology will be accepted; indicates market position
Government policy	Determines level and direction of R&D investments; is determined by market structure and public support

In earlier work we have designated these features as driving forces behind technological innovation (Van Schijndel and Ros, 2000), but here it is more appropriate to represent them as features or characteristics of the R&D lay-out, although they also influence the following innovations and implementations. These characteristics determine to a great extent the boundaries of the R&D investments, for example, when a new technology has a low compatibility with reference to the dominant technological regime, the R&D investments will most likely be inhibited.

The characteristics and determinants only sketch some of the features of the driving forces related to R&D investments. In order to be able to make a proper evaluation of the level and direction of R&D, it is necessary to have insight into policy instruments, market structure indicators and technological development indicators (see figure 3).

This inventory of indicators and instruments can indicate the *chances for breakthrough* of a certain technology or technology set. For our further evaluation we will first use an adaptation of the Porter Index variables. While Porter uses his indicators to characterise the innovative score of a country, we will try to focus them specifically on research for organic agriculture in The Netherlands. These indicators focus on the market structure of R&D for organic agriculture. We extent this set with some indicators on government policy and on the technological barriers as well.

Figure 3 Evaluation of R&D-arena



4.1.2. Choosing the R&D indicators for organic agriculture

In order to evaluate the characteristics of Arena 3 of the transition to an organic agriculture, we will have to score the R&D indicators in this arena.

Porter Index

Porter gives several indicators for the innovative structure of a country (Porter, 1990):

- number of employees in R&D jobs;
- R&D spending;
- openness for international competition;
- expenditure on higher education (% of BBP per capita);
- protection of intellectual property;
- BBP per capita;
- percentage of private R&D finance;
- percentage of R&D performed at universities.

Aggregated, these indicators represent the self-named Porter Index, which can be used to compare the innovative quality of a country. In order to evaluate the R&D on organic agriculture, we will have to adapt Porter's indicators. After focussing some of the indicators on the topic of organic agriculture, and by deleting the indicators that are too broad to allow for focusing, a proper set for organic agriculture could now be the following:

1. budgets and financing of R&D for organic agriculture;
2. private R&D versus public (academic) R&D.

In addition to these indicators, we need an insight in the government policy and technological development. These are domains are elaborated in the following indicators:

3. direction of research;
4. number of publications;
5. research networks;
6. policy support for knowledge development and innovations;
7. policy stability.

4.1.3. Evaluation of R&D indicators for organic agriculture

Budgets and funding of R&D for organic agriculture

The overwhelming majority of the research budget on organic agriculture is distributed by the Dutch ministry of agriculture (LNV). The ministerial budget for organic agricultural research (in the broad sense of the definition of 'organic'), for 2003 is about € 13M, which is roughly 90% of the total organic agricultural research budget. This covers essentially all research of relevance for organic agriculture. The national research budgets from the Ministry are planned to decrease slightly to € 12M annually for the coming years. This is quite remarkable, since other budgets on the stimulation of organic agriculture have been cut back much more dramatically, such as subsidies for farmers that alter their production methodology to the organic farming system (RIVM-MNP and Wageningen UR, 2003).

Other major funding bodies in the Netherlands for organic agriculture R&D are the combined Commodity Boards for dairy products, arable land farming and horticulture, which generate around € 1M for R&D on organic agriculture. The EU for its share has allocated funding for a major project within the Sixth Framework Programme on food safety and quality of organic products. Minor budgets are generated by the provinces and aggregate to several hundreds of thousands euros maximum.

The fact that most research is financially supported by LNV shows a high policy support for knowledge development and innovations on organic agriculture.

Well over 90% of the research is performed at the Wageningen Agricultural Research Centre (WUR), the main academic centre in the Netherlands on agricultural research. WUR has indicated its goal for the very near future to direct 10% of the research funds to organic agriculture. Also, there is a relatively small specialised research centre on organic agriculture and farming, the "Louis Bolk institute" (LBI), with around fifty employees. Finally, other institutes and universities perform several minor projects.

Private and public research

Although most of the research on organic agriculture is done at public institutions, rather than in a market construction, it should be noted that a fair lot of the innovative structure of organic agriculture may be developed on farms or in a learning-by-doing setting. Such innovations can often be generated with (very) low budgets, for which the largest Dutch bank in the agricultural sector, the Rabobank, has introduced special funding programmes for innovations and for sustainability programmes.

The private part of the R&D phase mainly concentrates on acquiring know-how for producers of organic products and for farmers in transition to organic production. LNV supports the dissemination of knowledge, which in practice is done by organisations such as Biologica Foundation. A specialised research programme in organic agriculture is supported by the WUR (*Innovatiecentrum Biologische Landbouw*), which concentrates on publicly financed research, the stimulation of innovations at farm level and dissemination of knowledge. Farmer's organisations (including the national farmers and horticulturists organisation, LTO) as well as organisations like the Innovation Support Office in Wageningen also mediate in farm-scale initiatives, although they focus for the most part on innovations in regular agricultural practice, and much less on organic agriculture.

Direction of research

Since most of the R&D on organic agriculture is financially supported by LNV, the Ministry is to a large extent able to determine the direction of the research. LNV has selected six bottleneck issues for research on organic farming (LNV, 2003): plagues and diseases, mechanic weed control, energy use and nutrient control in horticulture, soil and nutrient control, mineralisation of organic fertilisers and labour productivity.

The focus of the research is on primary production, e.g. research for alternative methods of pest control and fundamental research on multi-cropping or soil processes. Research on processes further up the food chain, such as epidemiological effects, is still in its infancy.

Much emphasis is laid on dissemination of research result, making them available for use in practice as early in the process as possible. Research is therefore to a large extent very practical and applied.

Publications

We have compiled a list of all scientific articles on agriculture in 2002 from the Science Edition of the Journal Citation Report (JCR, 2002), which added up to 15471 articles from 156 journals. This includes articles within the selected fields of agricultural economics and policy, agricultural engineering, agriculture, dairy and animal science, multidisciplinary agriculture and agronomy.[2] Dutch institutes contributed to 411 articles, which is 2.66 % of the total of articles.

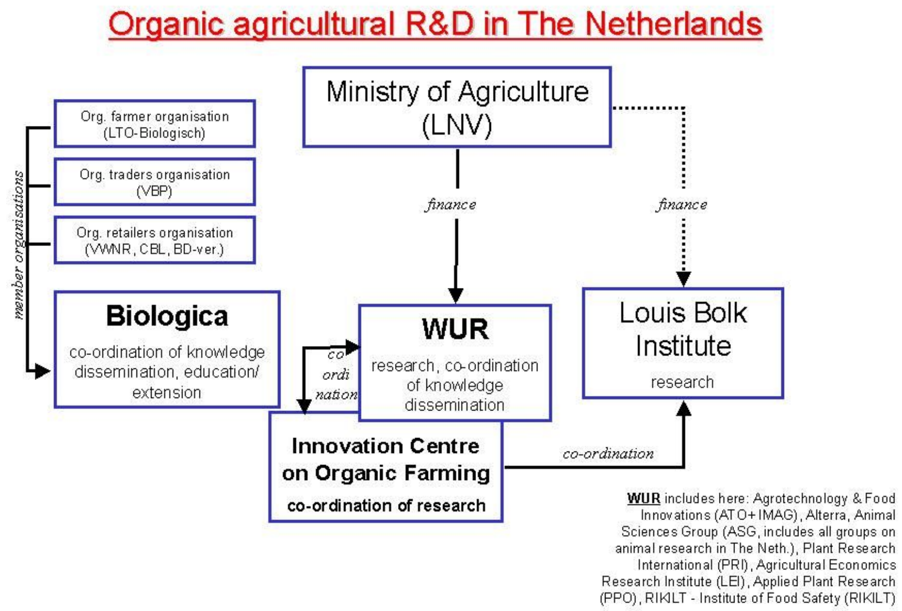
2 the JCR selection specifically *exludes* journals from the social sciences, which are collected in another database. However, some multidisciplinary journals are included here.

Of this selection 25 articles were selected on the keywords 'organic', however, most of these articles deal with subjects related with organic chemistry. Limiting the search to 'organic agriculture' or 'organic farming' yields 5 articles on the topic, which is 1,2% of all Dutch articles in the agricultural sciences. Two articles were written in international co-operation.

Research networks

The research network on organic agriculture in the Netherlands is highly determined by the financial currents and therefore mostly concentrates around the WUR. The Innovation Centre on Organic Farming, which is supported by WUR, co-ordinates much of the research in the country. This centre is allied to the Biologica Foundation. This foundation includes several co-ordinating organisations as members and therefore is able to mobilise much support and backing in the organic food chain. The Louis Bolk Institute (LBI) is an independent research institute. Figure 4 gives an overview on R&D for organic agriculture in the country.

Figure 4: network for organic agricultural research in The Netherlands



Technological development

Technological developments are dependent not only on market developments and policy structure, but also on the characteristics of technological barriers and compatibility with the present technological regime. It is not always easy to assess these characteristics with proper indicators, but it is possible to make a driving forces analysis, as can be seen in our short case study on the weeding robot. Since organic agriculture is very labour intensive (as it refuses to use pesticides), alternative weeding techniques are a hot topic for research. The weeding robot could be an interesting option here. This robot is an independent piece of equipment based on GPS techniques, which are used to distinguish structured patterns on the field (the crops) from unstructured patterns (the weeds). Expectations are that the first prototypes can be tested in about four years (LEI, 2003), but a full marketing is still considered to be at least ten years away (Ros et al, 2003).

The advantages for this technique are that the present weeding *alternatives* are either not acceptable in organic agriculture (i.e. chemical weeding), or are too expensive (labour intensive manual weeding). This obviously creates a market for this technique, although its development is clearly dependent to what extent it can overcome the disadvantages of the alternatives. A robot could replace 95% of the manual work and therefore could be a very attractive technology.

The disadvantage of this robot technique is presently that a fair bit of research is still necessary before a working model can be presented: the technique is still in its early development phase. This implies the necessity and a justification for continuous (public) *financing*, to ensure further development. At some point this will be taken over by private parties, once applications can be made and profits of marketing the technique are within sight.

Market chances can increase rapidly once stricter environmental standards originating from organic agriculture are applied more widely to common agricultural techniques. If chemical weeding is widely restricted, alternatives like the weeding robot may become attractive, stretching beyond a much wider market than organic agriculture (see Smits and Koole, 2002). This could greatly increase the *synergy* of development, possibly becoming a very important incentive for the development of the weeding robot, since the growth in the national market for organic products has been insecure for some years now. If the market remains as small as it is, potential new techniques may not be developed further for such a small market only. However, a dilemma can be recognised here, since the hampering growth of the organic production is at least partially attributed to the shortages in (seasonal) labour.

Policy stability

An important feature of the strength of the R&D arena lies in policy stability. A stable policy and market determines to a large extent the expectations of the research investor. Insight in the evolution of policy stability for research on organic agriculture could be quantified in terms of funding fluctuations and in the conditions for fund receiving parties. For this case study no insight is available yet on this issue.

4.1.4. Conclusion on Arena 3

From the above indicators we conclude the R&D-arena on organic agriculture in the Netherlands to be fairly active. Funding is relatively high and the research covers most areas of interest on this field, apart from epidemiological and toxicological studies on human health issues related to organic food stuffs.

Although funding and support is high, the research network is relatively small. One university performs about 90% of all (fundamental) research and most of the funding comes from the Ministry of Agriculture. This bears some risks for policy stability: if a new political course were to decrease (or increase) funding for R&D in organic agriculture, this would have immediate effects. Policy stability is hence very important here.

On the other hand, there is an increasing interest from private parties in the concept of organic agriculture, which may lead to the creation of new markets and hence stimulate further innovations in this field. We can tentatively conclude that the chances for a transition to organic agriculture (which is not necessarily the same as sustainable agriculture!) is supported by the present R&D level and direction.

4.2. Arena 4: Development of new forms of agriculture

4.2.1. Niche-markets for new developments

New forms of agricultural practice could prove to be the embryonal shapes of an innovated and sustainable agricultural system. The so-called first movers (or trendsetters), who introduce the new innovations in practice will often apply new concepts. Some typical new activities in the agricultural sector are agro-tourism, management of nature and landscape, and organic agriculture. These new activities can be characterised as expressions of *broadening* and *deepening* the fundamentals of traditional agricultural practice (Van der Ploeg et al., 2002). These activities create new sources of income for the farmer, as they extent the farmer's markets, either by offering a wider variety of products (broadening, e.g. agro-tourism), or by competing on the basis of added product quality (deepening, e.g. organic agriculture). Other new activities relate to a reconstruction of organisation of the agricultural practice, such as the new co-operative arrangements that seek to re-organise relations with the state and its policy makers (Van der Ploeg et al., 2002). An appropriate policy in this stage of the system innovation could relate to *strategic niche management*, which involves some level of protection for innovations on sustainability, to 'mature' them for later market introduction (Kemp et al, 1998; Kemp, 2000).

4.2.2. New initiatives in Dutch agriculture

Several new activities in Dutch agriculture are shown in figure 5, some of which show turbulent growth rates. One of these is the agricultural protection of landscape and nature (as a broadening of the agricultural practice), which is growing steadily at annual rates of up to 20% in terms of area. From the national statistics, we observe the area under agricultural nature management to be almost twice as large as the number of farms in this business, suggesting that the first movers are found among the large farms.

Figure 5: Some niche markets, 1980-2002 (RIVM, 2003)

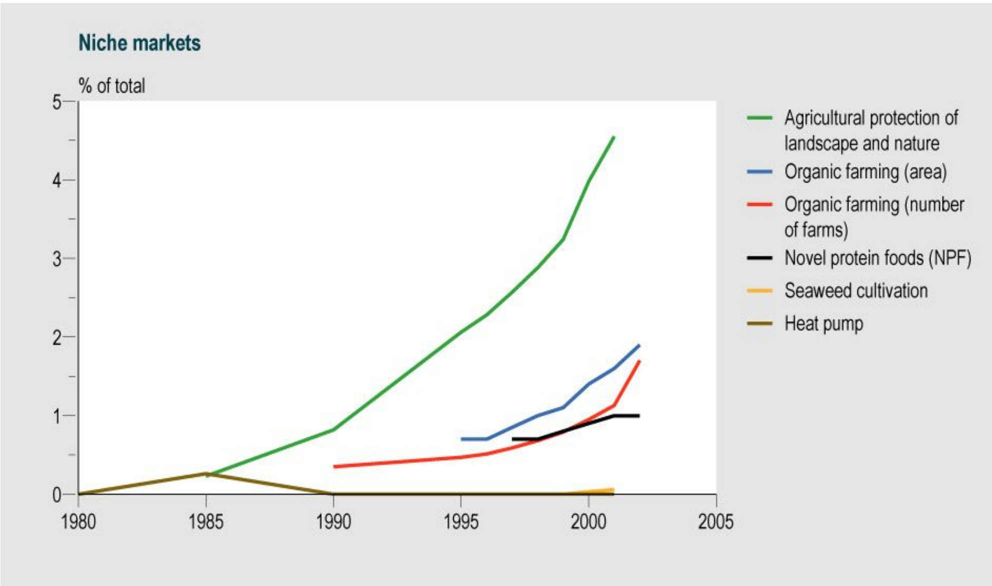


Table: Management of nature and landscape, 1980-2001

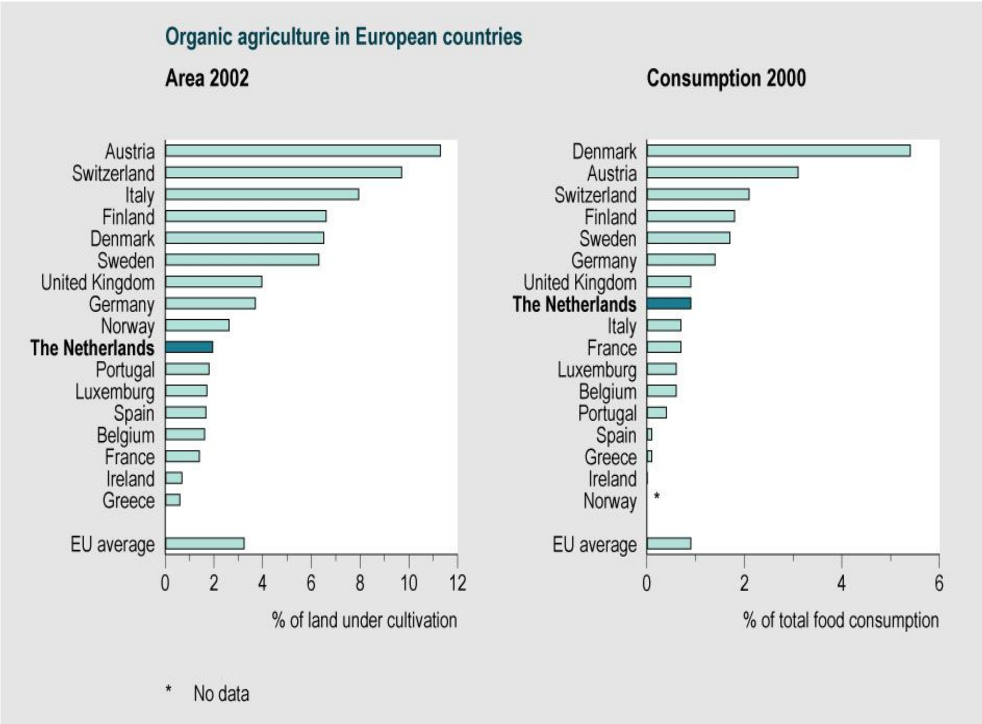
	1985	1990	1995	1996	1997	1998	1999	2000	2001
Agricul. nature management (% of total agricul. area)	0.23	0.82	2.06	2.28	2.57	2.88	3.24	3.98	4.55
Annual growth rate (%)				10.7	12.7	12.1	12.5	22.8	14.3
Agricul. nature management (% of total number of farms)						1.44	1.88		

Source: CBS (Statistics Netherlands)

The sales of novel protein foods (NPFs) showed several large increases of over 10% for some years, but this market has now stabilised to just under 1% of the meat market. An innovation that failed to take the market is the gas fuelled pump or heat pump, which uses methane gas produced by the livestock for heat production. Recovery time for the investment proved too long for most investors.

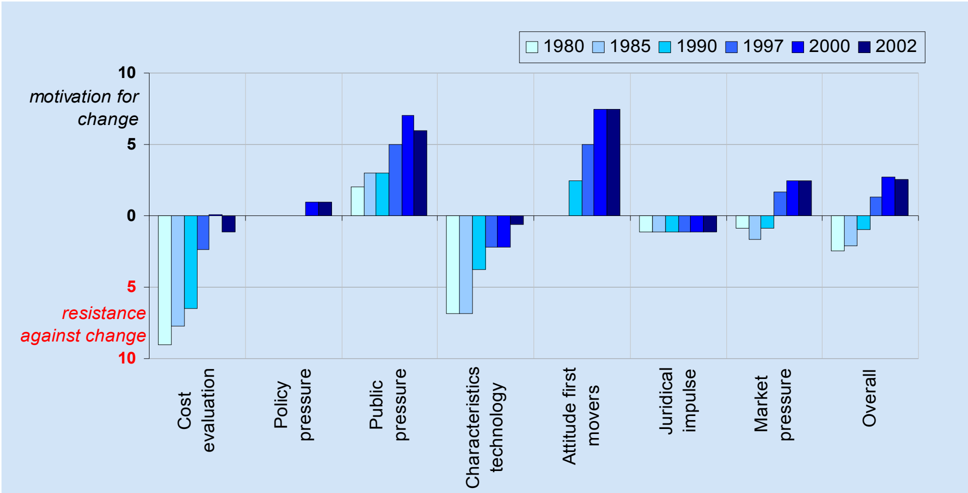
Organic agriculture shows an increasing number of farms, although their share is still small: 1.9% of the agriculture area in the Netherlands and 1.7% of the total farms. Compared with other European countries the Netherlands is average in terms of market share, a list that is topped by countries like Denmark, Austria and Switzerland (figure 6). In these countries the sale of organic products may be well over 60% in some common supermarkets. This can also be related to the much lower price added for organic products in these countries, about 20% lower than the European average. In addition, these countries usually employ a common national labelling system for organic products, which greatly increases consumer awareness.

Figure 6: Organic agriculture in Europe, by area and consumption level *(Hamm et al., 2002; Yussefi and Willer, 2003).*



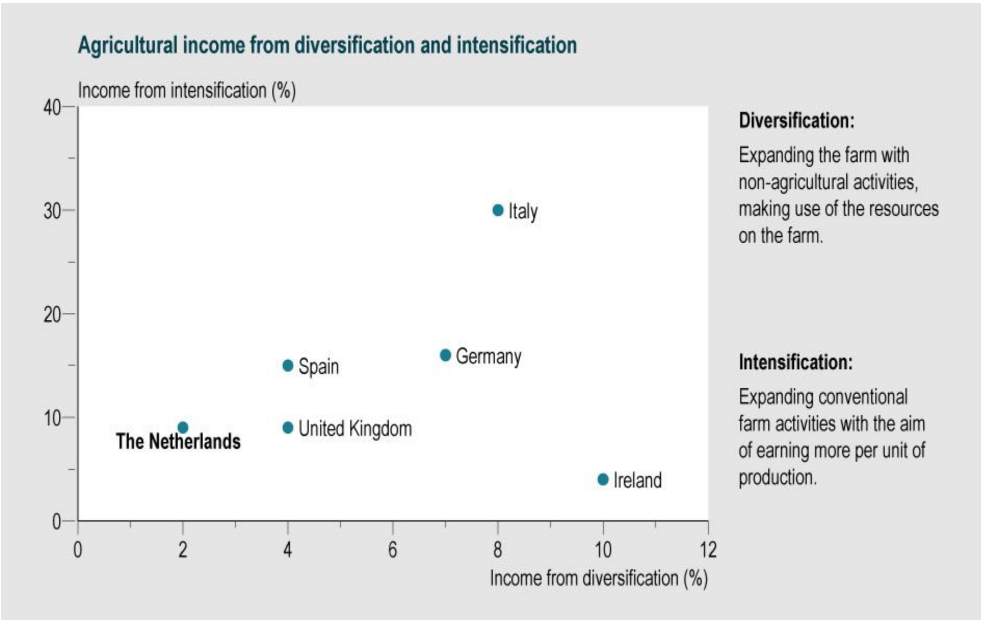
The food chain crises in Western Europe from the mid-nineties and thereafter have greatly enhanced the policy discussions and social pressure on changes in the set-up of regular agricultural practice (OECD, 2002). These crises have provided new market chances for alternative agricultural systems and opened markets for organic products, for example. On the production side of the food chain, dairy farms can be transformed to organic farms relatively easy. An analysis of driving forces on the first movers show that arguments for transformation change over time (figure 7). Main driving forces that play a role for the decisions that first movers make are: social, political and market pressure, farm economic evaluation, familiarity with the techniques, attitude of the first movers and judicial impulses. The overall (aggregate) positive force for changing to organic dairy practice arose at the time of crisis in common agricultural practice in the late nineties.

Figure 7: Driving forces on the first movers among the dairy farmers in the transformation to organic agriculture, 1980-2002.



First movers carry out many experiments on broadening and deepening their agricultural management, with some niches successfully arranged. However, compared with other European countries, the Dutch agricultural sector still realises only a relatively small income from the broadening and deepening of agricultural practice (figure 8).

Figure 8: Income from broadening and deepening of agricultural practice in EU-countries (*Source: Van der Ploeg, 2002, Edited by authors)*



5. Assessment of evaluation methodology

The evaluation of progress in system innovations is different from traditional environmental policy evaluation. The latter usually assesses from the perspective of the policy goals and analyses the efficiency of the policy for reaching those goals. The evaluation of a system evaluation takes the perspective of the process itself. Such processes usually involve some broadly described targets or future visions, much like 'sustainability' or 'open markets'. In order to be able to evaluate the progress towards such broad visions, we have developed a methodology that takes the assessment of the social activity in each phase of the system innovation as a starting point.

In this chapter we have described some elements of this evaluation method, splitting the process of system innovations in six characteristic phases, or *arenas*. These all have their own specific institutional setting, as well as social and political activity. Each can be assessed with quantitative or descriptive indicators, as we have shown for two of the six arenas. The social activities should be included with the choice of indicators. By showing (progress in) the most important indicators for each arena, policy makers can come to grips with the most important processes *and* participants in each phase of the transition process.

It should be noted that the indicators as such are not indivually indicative for system innovations. What makes them specific for system innovations is the clustering in arenas, each of which describes a phase in the process of system innovation. The arena-framework itself is specific for the evaluation of system innovations, as it takes the the perspective of the different phases of such a system change as a starting point. This method involves especially the early phases of a transition, which are often excluded or left for speculation. Finally, it incorporates a multi-phase approach with multiple levels of participants, institutions and technologies in one methodology. This method could therefore be better equipped than classic methods of evaluation, especially in distinguishing the first movers, fresh initiatives and new innovations. An extension of the conceptual framework of our methodology, especially on the relationship between the developments in the different arenas and the relationship between policies and the observed developments, could provide an even more solid evaluation method.

The case study described in this chapter on two stages in the system innovation for sustainable agriculture leaves some room for the assessment of our evaluation *methodology*. However, we cannot yet claim to provide a full insight in the actual assessment of the intended transition to a sustainable agriculture in the Netherlands. This is largely still due to a lack of data, which we intend to supply in future work. We believe that this methodology can provide a framework for the analysis of these data, as shown in the assessment done here in two of the arenas.

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