Managing technical-institutional design processes: some strategic lessons from environmental co-operatives in the Netherlands

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Abstract

In this paper the case of the environmental co-operatives VEL and VANLA is reviewed in terms of co-evolving technical and institutional change and the strategic lessons to be learned for a pro-active management of such complex technical-institutional design processes. Facing the many-sided crisis in agriculture the two co-operatives developed a radically different approach. The aim is to re-ground agriculture in local agro-ecological processes following the approach of lowering external inputs (i.e., material inputs, capital and labour). The results are promising: a system-innovation is emerging out of a wide range of connected novel operational practices (i.e., novelties) including technical as well as institutional aspects. The findings of VEL and VANLA stress once again the need for a simultaneous redesign of technical and institutional change to facilitate a transition towards a more sustainable agriculture. Furthermore, we conclude that this transition cannot but be rooted in promising, innovative practices that embody the potential to challenge conventional scientific approaches to sustainable agricultural development. More space should be created for 'smart' experimentation exploring and evaluating the potentialities of different transition paths.

Additional keywords: innovation, regime, multi-level perspective, strategic niche management

Introduction

Agriculture is confronted with changing societal expectations and demands as to its role in food production and in the countryside. Complying with these expectations and demands will require a comprehensive, far-reaching and therefore far from easy and long-lasting transformation of agriculture. Different approaches address this need for transformation differently, as for example the agro-industrial model versus the post-productivist model (Marsden, 2003). High-tech and capital intensive routes of transformation, aiming for high-output efficiencies in high-tech controlled production environments (shortly: upgrading), imply high private and public costs and therefore a considerable risk of massive capital loss, social capital included. Apart from private and public expenditures, transaction and governance costs, which include all other (possible) costs for having things work properly, are unpredictable at forehand but will be enormous anyway (Ventura & Milone, in press). When agriculture will be further disconnected from its ecological environment and natural ordering processes, the risk of agro-ecological disasters is increasing too (Van Der Ploeg, 2003; Groot Koerkamp & Bos, 2003). The impact of these risks has been revealed by successive crises in Dutch animal husbandry.

Contributions to this special issue sustain that members of the environmental co-operatives VEL and VANLA, in close collaboration with researchers involved in the VEL & VANLA Nutrient Management Project, are developing a radically different approach and promising transformation route that substantially reduces the above-mentioned risks and costs. The essence of the VEL & VANLA approach is the principle of downgrading, i.e., aiming for low-input efficiencies in a low-tech way by reconnecting agriculture to local ecological processes. The first results are promising: VEL and VANLA farmers do realize more sustainable farming practices at lower costs at farm level (Van Der Ploeg *et al.*, 2003), but also risks and costs at higher-order levels, e.g. at regional level, are significantly reduced. This is sustained by recent studies (Milone, in press). This reconnection (Van Der Ploeg, 2003) or reparticularization of farming (Roep, 2000) comprises a simultaneous re-design of both technical-biological (e.g. new ways of feeding and the production of 'good' manure) and diverse institutional and organizational aspects (e.g. developing new forms of governance and knowledge production) of operational farm practices. The technical-biological aspects cannot be separated from the institutional and organization aspects, they mutually (re)shape each other. This co-evolution of technical and institutional change is a general phenomenon (Rip & Kemp, 1998). We will therefore conceptualize the exploration of a particular transformation route or particular transition path (Rotmans *et al.*, 2000) by VEL and VANLA in terms of technical-institutional (re-)design.[1]

Innovation and transformation are complex and recursive processes. They are characterized by setbacks, creativity, confrontations, negotiations, uncertainty and contingency with all kinds of expected and unexpected obstacles to overcome but also by

[1] In this paper we shall also use the term ´socio-material´ as a synonym for technical-institutional. Both terms emphasize the interaction between and co-evolution of technical (or material) and institutional (or social) aspects.

steps forward, support and promising results. Visionaries and/or change agents play a crucial, leading role (Van Vliet, 1999; Roep, 2000). They articulate visions and expectations to create a supporting network of (new) alliances willing to commit themselves to a particular and promising route in order to mobilize the necessary resources (technical, political, financial, institutional, ecological and symbolical) for constructing a novel configuration that works (Rip & Kemp, 1998).

In this paper we want to demonstrate this complexity. First we will outline a conceptual framework regarding technical-institutional change. Then we will discuss the management of co-evolving technical and institutional change by introducing Strategic Niche Management (SNM) as a promising tool. Subsequently, the particular way technical and institutional changes have co-evolved in VEL and VANLA is re-told retrospectively along five strategic components. Based on this retrospective analysis we derive some strategic lessons from the VEL & VANLA case regarding strategic niche management and the management of transitions in agriculture. Finally we propose a revised, prospective framework for understanding the complex nature of technical-institutional design.

The complexity of technical-institutional change

The complexity of transformation processes is related to the multi-actor, multi-aspect and multi-level nature of technical-institutional change (Wiskerke & Van Der Ploeg, in press). In this issue on the VEL and VANLA co-operatives each contribution reveals some part of this multi-fold complexity.

Multi-actor nature

Novel, more sustainable farming practices are constructed by interactions between different (groups of) actors within a specific social and material (or ecological) setting. This setting might be constraining as well as enabling, but at the same time will also be reproduced or reconstructed by the actors themselves. Farmers with their co-operatives and researchers with their projects play a central role in VEL and VANLA. But at different degrees of distanciation, the whole 'world' somehow enters the local scene: policymakers at different governmental levels, extension workers, advisors, research-institutes, agro-industries, distributors and retailers, control and inspection services, consumers, inhabitants of rural areas and diverse interest groups of farmers, consumers, environmentalists, nature preservationists and, even though they are distant, WTO-negotiations. All these actors are participating in different, often overlapping social networks. All together these constitute a diversified social order stretching out in time and space. An order that is produced and reproduced by the routinization and objectification (i.e., institutionalization) of shared ways of doing, thinking and feeling (Berger & Luckman, 1967) and that functions as a social setting for actors. But beside a social component, one has to acknowledge that a particular institutional order has a material component as well that sustains it. Through the mediation of technology (Latour, 1994), shared ways of doing, thinking and feeling materialize and become embedded as a social code into e.g. a specific animal breed, a machine for applying manure, 'good' manure or even paperwork. This is where all kinds of natural ordering processes enter the scene too. Taken together one can say that different actor-worlds are co-produced and co-reproduced by ordering processes of different nature enabling and constraining in various ways the shape, content and impact of technical- institutional change.

Multi-aspect nature

As mentioned above, the shape and content of farming practices are enabled and constrained by diverse ordering principles of different nature. One can distinguish and study different aspects on their own or how they relate: cultural, political, economical and ethical issues but also physical, biological and chemical aspects. Institutional aspects regard for instance formal (e.g. legislation) and informal (social norms) rules or the constitution and working of markets. Ethical aspects regard for instance the acceptability of genetically modified organisms in food production and processing. One can study how farming (styles) relate(s) to ecological or biological processes or the working of an agro-ecosystem (e.g. De Goede *et al.*, 2003; Sonneveld & Bouma, 2003; Verhoeven *et al.*, 2003). Understanding this multi-aspect complexity asks for at least interdisciplinary and at best transdisciplinary study.

Multi-level nature

Farming is localized within dynamic, socio-material settings going from e.g. fields surrounded with hedge-rows to more distant socio-material structures as e.g. international trading or 'world' markets. One way to deal with this complexity is to distinguish different concentric socio-material spaces (or subsystems) in which farming is located and how these relate: e.g. field, farm, community, environmental co-operative (which in effect is a sort of community of practice; Wenger, 1998), region, nation/state and international or global systems. However, this is a static perspective on order, with the danger of losing oneself in drawing borderlines and of missing 'the action' or the ordering: i.e., how these spaces are co-produced and co-reproduced by all kinds of interacting social and natural ordering principles (Roep, 2000). An institutionalization perspective (e.g. Berger & Luckman, 1967) offers a more dynamic entrance for an inter- or transdisciplinary study of complexity distinguishing different levels of ordering:

1. The micro-level of localized individual and collective action;
2. The meso-level of institutionalized rule sets that guide and co-ordinate action;
3. The macro-level of social and material order (development of structures, organizations, systems) resulting from endured or embedded action which in turn sets the scene for action at micro-level.

Farming in the VEL & VANLA area is e.g. located within environmental co-operatives constituting a particular, multi-dimensioned (e.g. institutional and ecological) space for experimental farming. The co-operatives are in turn located within higher-order spaces. The co-operatives, being formalized institutional arrangements, serve like an intermediary between the outside and inside world creating room for experimentation and development of novel, more sustainable farming techniques.

A dynamic perspective on technical-institutional change

In retrospect the VEL & VANLA approach can be seen as the construction of a particular and, with regard to the results, promising transition path towards more sustainable farming practices. Before turning to the VEL & VANLA case and the lessons that can be learned from it for a more pro-active management of technical-institutional design, we will make a detour through literature regarding the complex, multi-level nature of technical-institutional change and the use of Strategic Niche Management (SNM) as a management tool.

Studies of technology dynamics distinguish three analytical levels (see Figure 1) to order the complex dynamics of (socio-)technical change:

1. The micro-level of *niches*, where novel configurations that promise to work (novelties) are tested on their applicability in a protected space;
2. The meso-level of *regimes*, guiding (incremental) change along technological paths;

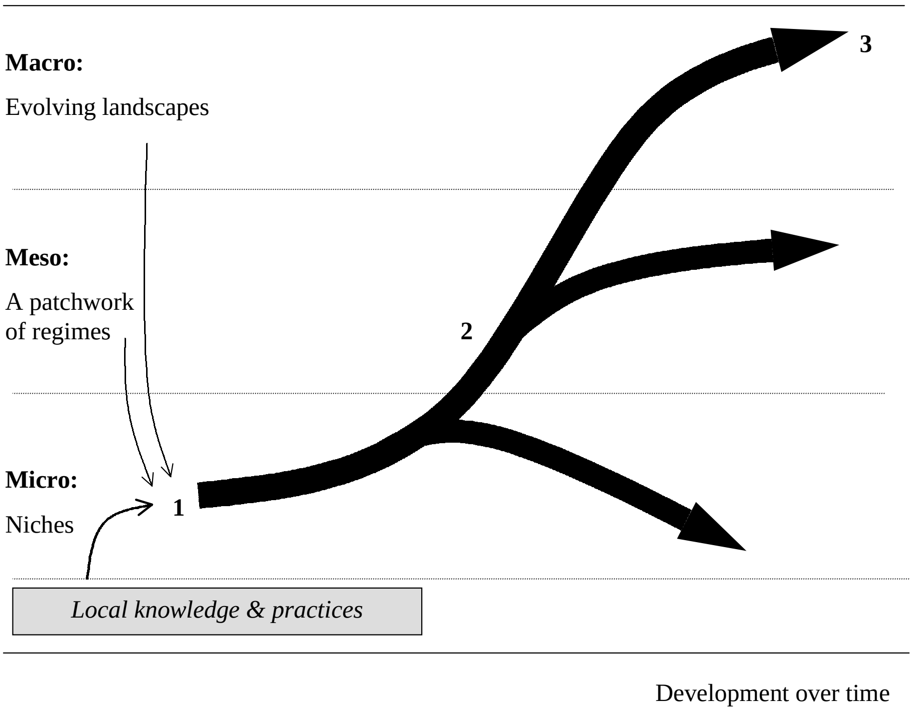

Figure 1. The multi-level dynamics of transitions. 1 = novelty creation; 2 = novelty evolves, is taken up, may modify regime; 3 = landscape is transformed. After Kemp *et al.* (2001).

3. The macro-level of *landscape*, reflecting structural developments.

Niches

To create and develop novel techniques, change agents (a role that might be fulfilled by anyone ranging from farmers and engineers to politicians or policy-makers) build niches to experiment and protect still vulnerable, immature novelties against a possibly hostile selection environment in order to make them more robust. Maturing is a gradual process based on learning (Hoogma, 2000). Learning about the working and performance of a novel configuration is an important function of niches. Learning is always located within a specific social and material context (or actor-world). This might be obvious for field laboratories in the VEL & VANLA case (Stuiver *et al.*, 2003), but also holds true for high-tech research laboratories. So, the knowledge generated and the novel techniques developed are contextual too; it cannot be transferred from one context to another just like that. It needs to be de-contextualized and re-contextualized, which implies learning about how things work under what conditions. Actors – like engineers, stakeholders, users, interest groups, governmental agencies – involved in creating and maintaining a niche or in learning about promising novelties have their own strategies based on what is at stake and on their expectations regarding the performance of novel configurations. But as a result of ongoing learning processes these will change too. If, in the course of time, 'experiments' prove that a novelty works and has some promising innovative potentials, expectations regarding this new configuration will become stronger. It will become easier to expand the actor-world. Through consecutive cycles of learning processes, expanding networks and alignment of strategies and expectations the process will gain more momentum and bring about a more stable and robust novel configuration. At the same time institutional arrangements will co-evolve and new rule sets or regimes emerge. A range of (radical) novelties might in time be linked or welded together into system-innovation at the level of a societal domain or sector, e.g. new systems of energy production, transportation or food production. If these system-innovations can comply better with changing societal needs or structural developments at the landscape level this can provoke a regime shift. So, niche formation and maintenance to facilitate experimentation and learning processes located within niches are crucial for bringing about radical technical-institutional change.

A patchwork of regimes

Rip & Kemp (1998) defined a (socio-technological) regime as *"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."* Basically regimes are shared sets of cognitive, social and technical rules that guide or govern technical change along certain technological paths or trajectories. They can be analysed e.g. in terms of paradigms, search routines, research styles or more generally modes of ordering (Law, 1994). The concept of regime introduces an institutional perspective on technical change. Rip & Kemp (1998) emphasized how regimes guide the variation in the production of technical change. Eventually these rules (as a kind of social code) become materially embedded in techniques. Geels & Kemp (2000) have broadened the concept of regime by also including the rules prevailing in the selection environment (i.e., market, government, interest groups, and users), because these guide and shape technical change as well. Regimes are produced and reproduced in social interaction, in more informal networks and in formalized organizational structures (programmes, projects, research institutes, and regulations). By means of co-ordination and alignment and by gaining momentum along a technological trajectory a regime results in a semi-coherent but heterogeneous (i.e., having a social as well as a material component) configuration. These configurations can expand to large systems that dominate technological change in a complete sector for some time and thus to a great extent shape the landscape. This expansion has for instance been the case in the post World War II modernization of Dutch agriculture (Wiskerke, 1997; Roep, 2000; Van Der Ploeg, 2003).

The notion of regime and trajectory helps to understand why most technical change is incremental and focused on system optimization, rather than radical and oriented towards system innovation. Vested regimes, with all their actors and different interests, are obstructing a breakthrough of radical changes. Even more, dominant regimes also tend to create ignorance with respect to alternative technological trajectories. In times of crisis, like in agriculture nowadays, this expresses itself as the institutionalized incapacity to respond to societal change (Roep, 2000). In the VEL and VANLA co-operatives this has become quite evident: a lack of adequate (scientific) knowledge on chemical and biological soil processes (De Goede *et al.*, 2003; Groot *et al.*, 2003; Sonneveld & Bouma, 2003), on the relation between high fibre/low protein diets and slurry manure quality (Reijs *et al.*, 2003; Verhoeven *et al.*, 2003) and on the relation between diets and animal health. During the modernization era, knowledge and technological capacity were narrowly aimed at the maximization of primary production (Roep, 2000) and consequently at the maximization of different subsystems instead of the optimization of the soil-plant-animal system as a whole (see Stuiver *et al.*, 2003).

Landscape

The landscape provides the overall but variously shaped and multi-dimensional context for technical change. It needs long lasting, structural (material-technical as well technical-institutional) developments as the outcome of co-evolving technical and institutional change at lower levels. These developments shape the landscape so to speak, although the landscape in turn channels lower-level dynamics. The landscape is constraining as well as enabling technical change. Structural developments can put pressure on existing regimes, creating windows of opportunity for more radical change. One could for instance argue that recent crises in agricultural and food production eventually re-shape the landscape (closing down some routes while opening others) as a result of current political, scientific and societal debate on the future of agriculture. This might facilitate or create room for a regime shift, moving away from the vested agro-industrial technological trajectory towards a new trajectory based on multi-functional agriculture.

As reflected in Figure 1, the relation between the levels is not static but dynamic. The different levels mutually shape and re-shape each other. Novel configurations are developed in niches, protected from but nevertheless influenced by developments at regime and landscape level. Policies and legislation for example, shape strategies and expectations in niches. At the same time expectations and the creation of novelties influence developments at the regime and landscape level. This multiple and dynamic connection between the levels is an important feature of technical change.

SNM as a tool for pro-active management of technical-institutional change

For some decades agriculture has been dominated by a modernization regime that has (re)shaped the socio-material landscape profoundly. The unsustainable nature and many crises of the modern, agro-industrial food supply chain are now widely acknowledged. Apart from optimizing the agro-industrial model, ideas and visions on alternative routes are presented, like for instance a reparticularization of farming or 'downgrading' by innovative farmers or numerous farmers' collectives such as VEL and VANLA. By means of *in situ* experimentation and mutual learning between farmers and researchers (Stuiver *et al.*, 2003) innovative farmers have produced an impressive range of promising novelties (Roep, 2000; Roep *et al.*, in press; Swagemakers, 2002; Wiskerke, 1997). However, within the still prevailing, dominant regime, many of these novelties remain undiscovered. They are, in other words, hidden novelties. The question then is how to discover these promising, but still hidden novelties and enhance their diffusion in order to facilitate transformation.

Kemp *et al.* (1998, 2001) proposed the construction of desirable transition paths through the strategic management of niches. Strategic Niche Management (SNM) is developed as a tool for simultaneously managing both technical and institutional change, smoothing the diffusion process of promising novelties. Knowledge and expertise of users and other actors, like policy-makers, researchers or representatives of public interests, are brought into the technology development process, conceptualized as smart experimentation (Weber *et al.*, 1998; Hoogma, 2000). SNM is the creation, development and controlled break-down of niches for promising novel technologies and concepts by smart experimentation with the aim of learning about the desirability (e.g. in terms of sustainability) and enhancing the rate of diffusion of the novel technology (Hoogma *et al.*, 2002). A niche is 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 improving the novelty and the development of a new market."* (Hoogma *et al.*, 2002). The strategic aspect is that novel, but still unstable and vulnerable techniques are gradually exposed to the selection environment. This enables the full exploration of their promises and potentials to end-users. It also enables the development of enough momentum to provoke a breakthrough of a more radical innovation and a reversal of regimes (Kemp *et al.*, 2001).

However, a regime shift, implying a shift in the mode of technological ordering towards another technological trajectory, cannot be brought about by niche development only, let alone by SNM. It requires other dramatic changes in or a transformation of the vested order at landscape level as well (Geels & Kemp, 2000; Geels, 2002). Examples of dramatic changes or transformations are the exhaustion of opportunities within the prevailing technological trajectory, a profound crisis within the societal domain and the emergence of new societal values and needs and as a consequence a radical change in policies. Nevertheless, as its aim is to set in motion a transition path, SNM is an important tool in managing long-term societal transformations or transitions (Rotmans *et al.*, 2000).

The management of niches can be done by firms, governments, and other social actors (operating as change agents), but not necessarily in a systematic and co-ordinated way (Kemp *et al.*, 2001). Different actors have different interests, technological capabilities, powers, belief systems and expectations. Moreover, there are usually several technological options or paths to go that can compete with each other. But how are niches then created and managed? From a managerial rather than a process perspective, SNM consists of five interrelated steps (Kemp *et al.* 2001; Weber *et al*, 1998):

1. The choice of a novel technology based on its potential;
2. The selection of the experiment and its location;
3. The set-up of the experiment balancing between protection and exposure to selection pressure;
4. The scaling up of the experiment by policy support either financially or regulatory, having in mind that policies are the outcome of bargaining and compromise between societal actors and coalitions in a context of multiple goals, conflicting interests, and uncertainty;
5. The phased breakdown of protection when results are disappointing or prospects dim or when a novel technology has proven itself to survive in 'real' world as part of a robust (system) innovation.

Keeping in mind that SNM is not a matter of simply applying a number of formalized steps in disrespect of the specific context and neither a guarantee for success Geels & Kemp (2000) argued 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 stabilization of a social network or, when explicitly including the material component as we proposed, of an actor-world;

Novelty creation and SNM in agriculture: some specific features

SNM was initially developed – by the 'Twente school' – in science, technology & society studies (Hoogma, 2000; Hoogma *et al.*, 2002; Kemp *et al.*, 1998, 2001; Rip & Kemp, 1998), as 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 on, as explained above, it became part of a broader framework: the build-up of new technological regimes and the possibility of intentionally working towards desired regime change. However, in this paper we deal with agriculture. Differences in the nature of farming imply both empirical and theoretical differences with respect to novelty creation and SNM. We will shortly address some specific, interrelated features of agriculture.

The first difference regards the specificity of the location and nature 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). Specific for farming is that agricultural production involves the transformation of dead and, more specifically, of living matter. Additionally, because of the open relation with the agro-ecological environment farming is located in, it is an open system. So, agricultural production is subjected to all kinds of uncontrolled processes, which make it rather unpredictable too. Although this has been the subject of agro-technological development, farming still depends, albeit in different degrees, on the working of uncontrolled 'natural' processes and therefore on farmers knowledge of how things work locally (Stuiver *et al.*, 2003). 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 relevance for knowledge development and innovation: must it be based on diversity or, on the contrary, overcome it?

A second, related difference regards the location and nature of novelty creation. In (high-tech) industrial sectors novelty creation is located mainly within specialized, capital intensive and isolated research and development (R&D) centres. Few industrial conglomerates dominate the R&D scene. 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 hampered innovation and diffusion. From the early 19th century onwards a public-funded system for applied research, education and extension has been 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 sustaining diversity. This changed fundamentally in the post World War II modernization of agriculture when a mono-functional, productivist perspective on agriculture became institutionalized (Marsden, 2003; Van Der Ploeg, 2003; Roep, 2000). Within this mono-functional productivist 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 unnoticed. Nowadays, with modern agriculture in crisis, a re-particularization of farming and subsequently a re-grounding of innovation in diversity and novelty creation by farmers is considered 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 experimentation by farmers is such an important storyline in the strategic management of the VEL and VANLA co-operatives as a particular niche.

The VEL & VANLA case: strategic components of niche management

As many of the contributions to this special issue demonstrate, the VEL and VANLA farmers have successfully developed a range of interconnected and carefully balanced novelties, resulting in a more sustainable development of farming and the rural area. A system innovation is emerging, symbolically referred to as the 'soil-plant-animal system'. Although the job is not done yet because a reversal of regimes is still far ahead, in retrospect the VEL & VANLA case can be re-told as a successful form of SNM, i.e., of successfully managing the co-evolution of technical and institutional change. The success is based on an effective combination of five, interrelated strategic components: (1) self-governance, (2) enrolling capacity, (3) heterogeneous knowledge production, (4) integration, and (5) effective reformism.

The components can be understood as a detailed, adjusted and fine-tuned elaboration of the three processes shaping SNM mentioned by Geels & Kemp (2000) (see above). The components also underlie different episodes in the history of the VEL and VANLA co-operatives (see Wiskerke *et al.*, 2003). Together the components describe the multi-dimensional nature of the alignments, tensions and conflicts linking the VEL & VANLA niche to the prevailing regime.

Self-governance

This first component refers to the capacity to manage both the internal relations within the niche and the interrelations between the niche and its institutional environment in a more convincing, adequate and effective way than a straightforward application of the rules by the prevailing regime would imply. Within the VEL & VANLA niche several practices are 'governed better' than elsewhere, e.g. neighbouring areas.

One expression of self-governance is to be found in the realized management of nature and landscape. In order to be effective, this activity requires a high degree of participation. If not, isolated pieces of 'nature' and 'landscape' are the far from satisfactory outcome, which hardly allow for the required space and interconnections needed to support elevated levels of biodiversity (Geertsema, 2002). It is precisely in this respect that the effectiveness of self-governance by the two environmental co-operatives emerges. VEL and VANLA succeeded to get 90% and 70%, respectively, of the farmers involved in activities connected with management and improvement of nature and landscape. Several institutional and organizational novelties turned out to be strategic in this respect. These are, amongst other things, the local design of adequate 'management packages', the newly developed practice of so-called '*zittingsdagen*'[2] and the introduced practice of local social inspection (Atsma *et al.*, 2000). But the fact that local leaders, instead of state officials, explain to other farmers the relevance of nature and landscape management, might also be an explanation for the high levels of partici-

[2] 'Zittingsdagen' are days of session in which trained members of the co-operatives assist other members to do the paperwork associated with the elaboration of contracts for nature and landscape management.

pation. Nowhere else such a high level of participation has been realized. It allows provincial administration to base their regional management plans on the set of farm management plans, which is unique too.

The high level of participation in nature and landscape management illustrates that because of the niche, the actors involved are able to realize a better performance than would have been the case without such a niche. The same applies to the environmental track. In 2001, 67% of the 55 farmers joining this track already realized the goal set for 2003: a nitrogen (N) loss equal to or lower than 180 kg N ha^{-1}. For all 55 participants this implies that their average N losses in 2001 were equal to 172 kg N ha^{-1} (Verhoeven *et al.*, 2003). Here again it can be said that such a score is hard to encounter in other Dutch projects that aim at a reduction of N losses on dairy farms (Doornewaard *et al.*, 2002; Muller, 2002).

Effective self-governance then, is the capability to 'do better'. It is the capacity to create promises and to fulfil, albeit partial, these promises. These (partially) fulfilled promises result in a better and a more convincing record than can be realized under the 'old' regime. In turn, this evidently creates more space for questioning the regime and a (re-)negotiation of the rules. It is important, if not decisive, to be able to deviate from generic rules. Without the negotiated room for manoeuvre, the development of the indicated practices and associated ability of self-governance would have been blocked. Hence, obtaining room for manoeuvre is a strategic pre-condition for self-governance. The very improvement of governance by itself becomes an argument for defending and, sometimes, for extending this room for manoeuvre. This links to a second component, i.e., enrolling capacity.

Enrolling capacity

This second component refers to the capacity to involve, engage, mobilize and use the support of 'others' in order to create, defend and expand the required room for manoeuvre. The creation and maintenance of the indicated room for manoeuvre has been far from easy. Neither has it been a smooth and uni-linear process going from reduced to expanded self-regulation. In retrospect the mobilization of the Standing Committee on Agriculture of the Dutch Parliament to correct administrative or political decisions of the Ministry of Agriculture, Nature and Food Quality has been decisive. This committee has intervened several times (directly of indirectly) on behalf of VEL and VANLA. Members of Parliament from different political parties have been invited to the area and some even played a role in strategic discussions. Simultaneously, for politicians the very experience of VEL and VANLA represents an important point of reference to critically examine policy measures, simply because VEL and VANLA represent a practice indicating that things can be done better.

The link to Parliament is strengthened by the fact that VEL and VANLA receive considerable financial and political support from a broad, intra-sectoral range of local and regional interest groups and political bodies, such as the Province of Friesland and the Frisian Nature Movement, as well as considerable coverage in the regional and agricultural press. This broad and diverse local and regional support made VEL and VANLA of special interest to national politicians. The co-operatives emerged as intermediating points *par excellence* for the need and the opportunity for reconciling policy contradictions by politicians. VEL and VANLA emerge then as a concrete and convincing beacon for a promising trajectory that might be followed elsewhere.

The enrolment of a large support network is indispensable to overcome all kinds of obstacles put up by the 'old' regime, for instance raising funds for *in situ* experimentation. Niche formation and maintenance can be a highly delicate affair. A niche is not only a protected space for producing and nurturing novelties, the niche itself needs to be protected and nurtured as well.

Heterogeneous knowledge production

The creation of new, convincing 'facts', of new knowledge on the seemingly impossible integration of knowledge from different sources (explaining the adjective heterogeneous), has been and still is of crucial importance in the creation, development and defence of VEL and VANLA as evolving niches (Stuiver *et al.*, 2003). The engagement of a group of interested scientists founding and legitimizing the 'expectations' of the VEL & VANLA approach and the subsequent controversies and debates among scientists, and between scientists, farmers and policymakers, was then of crucial importance too.

In essence, the VEL & VANLA approach is about managing and developing local specificity. From the very beginning, when the two co-operatives were founded, the main expectation was that things could be done better, i.e., managed and developed better, if done differently. That is to say, different from the (generic) procedures and approaches entailed in the dominant regime. The argument was that the management of nature and landscape and environmental schemes could be far more effective if based upon farmer's knowledge of the local and upon local appropriate designs. One can imagine that from the perspective of the dominant regime this very claim was distrusted. It was seen as a way to escape regulations and formal procedures, in other words, as farmers obstructing the law. Hence, from the very beginning self-governing and enrolment capacities were required to show and to assure that no escape or sabotage would be possible.

When the VEL & VANLA Nutrient Management Project was formulated most scientists and policymakers were still convinced that slit injection of slurry manure into the topsoil was the most effective way to reduce ammonia losses and most easy to control too. The obligatory MINeral Accounting System (MINAS, i.e., the regulatory instrument to control and to reduce mineral losses, especially of N) (Henkens & Van Keulen, 2001) and the machinery for slit injection became symbolic for this approach. The questions raised by the founding fathers of VEL and VANLA that the machinery for slit injection did not 'fit' in the local landscapes, that the obligation to use it would even increase N use and that there were simple but effective alternatives (Atsma *et al.*, 2000) were simply perceived as not valid or, anyway, as irrelevant. The proposed alternatives were regarded as impossible or at least as inadequate, also with respect to the issue of controllability.

In this respect two 'data' are very telling. Firstly, the founding fathers of VEL and VANLA frequently referred to some specific practices embedded in the heterogeneity within their area, i.e., specific practices that seemed to indicate that alternative approaches had already been developed *in situ* and could probably very well be extended to more farms (Van Der Ploeg, 2003). However, being specific was precisely the reason why these experiences were considered as mere random deviations, i.e., as not relevant. Secondly, the outline for a scientific programme to unravel the 'deviations' referred to here above, was completely de-legitimized by some vested research institutes in an assessment of the programme (Renting & Van Der Ploeg, 2001).

Having now at our disposal the first set of comprehensive results created by the VEL & VANLA project along the environmental track, as well as a series of new, solid scientific insights into the backgrounds of this new track (see the contributions to this special issue), it seems to be quite superfluous to re-discuss these initial difficulties. However, when trying to obtain a better understanding of the dynamics of strategic niche management, they are key events. Firstly, because they illustrate the problematic relation between the dominant regime and a particular niche, between the generic rule and local particularities and between generalized, formal knowledge and, often tacit, knowledge of local particularities. Secondly, because this problem is not limited to the 'take-off' stage. Learning to understand specific problems, solutions and potentials of more sustainable farming practices is essential in this type of niche management.

From the perspective of the dominant regime local specificity is seen as an obstacle to overcome. Diversity is at odds with the application of generic rules, procedures and methods and with the principles of simplicity of prescription and of easy inspection. It is relatively easy to check whether or not all farmers use the prescribed machinery for slit injection. It is far more difficult to check whether or not farmers are producing 'good manure' and applying it in a 'proper way'. This difficulty especially remains as long as inspection is oriented at the means prescribed instead of at the goals that should be met and as long as administrative bodies effectuate inspection. It might well be the case, as illustrated by the typical 'Drogeham plots' within the grassland experiment (see Schils & Kok, 2003; Verhoeven *et al.*, 2003), that with 'good manure' and a 'proper' application, N efficiency and N recovery are increased considerably. However, within the dominant regime these are 'monstrous' findings: very little can be done with them.

The environmental route proceeded by VEL and VANLA and its highly debated results are an exemplary illustration of the clash between the generic rules of the dominant regime and the need for local specific approaches. It also demonstrates the strategic importance of heterogeneous knowledge production and of mutual learning between farmers and researchers in an experimental setting and therefore of the importance of committed farmers and researchers. Together they are able and capable to follow the road of discovering and exploring the specific potentials and constraints of the local circumstances.

Integration

Integration refers to the degree in which different projects, aspects and levels are tied together into an organic, properly working whole, gaining extra momentum from synergy effects.

In spite of the high degree of 'institutional thickness', where formally everything is co-ordinated with everything, we are often confronted with the opposite in every day life. In the arena of policy and agriculture this is anyhow very manifest. It turns out to be very difficult to combine and reconcile nature policy, landscape policy, agro-environmental policy, animal health prescriptions, quality requirements, and so on and so forth. Moreover, there is the difficulty to cope with municipal prescriptions and rules, provincial regulation, national regulation schemes and requirements stemming from the European Commission.

In the Frisian Woodlands and its typical agro-ecological setting, all these problems emerge. Simultaneously, there is an urgent need here to find integrated solutions. An integrated solution might be more effective in terms of the goals met and even be cheaper in the end. This was one of the main driving forces for founding the two co-operatives. A straightforward implementation of the then prevailing agro-environmental schemes within the small-scale landscape would imply very high costs for the farmers, but would also be detrimental to both the environment and the landscape and the embedded natural values (Renting *et al.*, 1994).

VEL and VANLA initiated a search for new, more integrated designs. This has resulted in various novelties, such as the 'area-friendly' machine for slurry manure application (Atsma *et al.*, 2000), adapted ways for surface application of slurry manure (Van Der Ploeg *et al.*, 2002), contracts with the national government to be permitted to do so (Renting & Van Der Ploeg, 2001; Wiskerke *et al.*, 2003), the possibility to extend the timing of slurry manure application beyond the 1 September limit (Atsma *et al.*, 2000), the 'construction' of better manure (Reijs *et al.*, 2003; Verhoeven *et al.*, 2003), the re-discovery of the relevance of soil biology (De Goede *et al.*, 2003) and new cutting practices (Van Der Ploeg *et al.*, 2002). The basic feature of all these novelties is that their high level of integration could only be constructed by departing from the specific and a re-balancing of farming in a step-by-step process of learning by doing. This integrated whole of novel practices cannot but further strengthen the specificity of the area.

Effective reformism

This component refers to the capacity to develop integrated and expand new practices that are convincing both internally and externally. VEL and VANLA have been able to reform the practice of nature conservation and landscape management in such a way that very large and interconnected areas have now become an objective. Simultaneously, they reformed local agro-environmental approaches in such a way that the area is having an outstanding record in this respect. This is clearly demonstrated by the results achieved by VEL and VANLA (see the other contributions to this issue). Also the fact that the two co-operatives received several prices: from the Ministry of Public Housing, Spatial Planning and Environmental Affairs (VROM), from the Frisian environmental movement and from the Northern '*BoerenNatuur*' (farming and nature) organization.

In the eyes of many outsiders it is effective reformism that associates with the notion that the two environmental co-operatives have the capacity to deliver, i.e to realize expectations. The co-operatives are able to do what elsewhere remains fragmented or limited to embryonic forms. Internally this effective reformism translates into coherence and synergy (Brunori & Rossi, 2000). For the farmers involved, effective reformism implies that economic gains can be made in the fields of activity of the co-operatives and that the accumulated effects are contributing substantially to the economy of the farms and of the region as a whole (Van Der Ploeg *et al.*, 2003). So, farmers' impression is that fewer farmers stop farming than in neighbouring areas.

Self-governance, enrolling capacity, heterogeneous knowledge production, integration, all these components result in effective reformism. However, it is not a mere addition. Effective reformism refers to intentions, opportunities and projections, to the thus induced practices (hence, reforms) and to the associated results and outcomes (hence, effective). It also refers to the capacity to weld together a range of novelties into a coherent working whole, emerging as a system-innovation. This in turn triggers and inspires the development of new novelties and the establishment of new levels of integration; it becomes an evolving programme. Effective reformism results in new blocks of heterogeneous knowledge, indicating that the seemingly impossible might well become a convincing and solid new reality. And it urges for new levels and forms of self-governance. Effective reformism refers to the capacity to get things done, resulting in a positive record (e.g. lower nutrient losses and lower costs compared with conventional farms and approaches) that further strengthens the alliances and the supporting network. This positive record underlines the differences between the results of the dominant regime and the VEL & VANLA approach. Thus, effective reformism results in additional arguments for strengthening, defending and extending the niches concerned: progress is made in the construction of a particular transition path.

Recently, the co-operatives have taken another step forward. Together with four other environmental co-operatives in the region, VEL and VANLA founded the regional umbrella co-operative '*Noardelike Fryske Wâlden*' (Northern Frisian Woodlands) that aims to integrate, co-ordinate and further expand their fields of activity. They are working towards a novel institutional arrangement: a regional contract with the government in which the co-operative is paid for the supplied green services. Their programme aims to integrate and create coherence and synergy between eight fields of activity:
1. Management of nature and landscape;
2. Improvement of environmental quality and water management;
3. Integrated food supply chain approach;
4. Public relations and tourism;
5. Cost reduction;
6. Improvement of animal welfare and health;
7. Construction of a soil bank;
8. Production of green energy.

Effective reformism thus implies an unfolding programme exploring and realizing step by step a transition of agriculture. VEL and VANLA have time and again been able to formulate adequate versions of this unfolding programme. Also the auto-evaluations, elaborated for the Ministry of Agriculture, Nature and Food Quality, can be read as subsequent steps of this unfolding programme. The same goes for internal publications and speeches at local meetings. Important in these expressions of the unfolding programme is that they (1) strongly reflect regional values, norms and attitudes, (2) stress time and again the opportunity of new local approaches, and (3) indicate concrete prospects for emancipation.

Concluding remarks

From the retrospective analysis of the evolution of the environmental co-operatives VEL and VANLA and the associated activities, we can draw two types of conclusions. First of all we can derive several practical lessons for SNM in agriculture. Second, the retrospective analysis of VEL and VANLA in terms of strategic components of SNM calls for a broadening or revision of the conceptual and analytical framework outlined in the beginning of this paper (see also Figure 1).

Lessons learned for SNM in agriculture

1. Create and maintain a learning environment

The VEL & VANLA case shows 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 relevant actors have (and develop) during the process of novelty creation. Third, it is important to learn about organization, network building (i.e., enrolment of others) and niche management (i.e., self-governance) 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, especially in the initial stages, a critical success factor. By referring to the novelties hidden so far (to the 'deviations from the routine' as we described them before), these hidden novelties are actually 'facts' that are brought into the discussions and negotiations and not just mere plans and 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. 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 towards 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 (researchers, extensionists, farmers' unions, etc.) and the endogenous development potential as needed in the local constellation (the promises resulting from the local 'deviations from the routines'). In the end, (re-)design is all about making new and effective connections. Precisely here the basic 'triangle' is crucial. It makes local practices and resources into a starting point for further processes of unfolding.

4. Creating alignment is a continuous process

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. Like it is the case with actors' expectations and strategies the stability of a niche is or can be of a temporary nature. Continuous self-governance 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, that is, to 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 involved are to improve their own situation and prospects. If there is no progress or reciprocity at the level of both 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 landscape level, putting pressure on the dominant regime, and the room for manoeuvre at the local level. Their capacity is to envision windows of opportunity, express expectations and enrol alliances. The VEL & VANLA case, sustained by other experiences, has taught us that in agriculture local leaders (not necessarily farmers) can play an important role as visionary or change agent.

A revised framework for studying and managing technical-institutional change

Based on the retrospective analysis of VEL and VANLA and several similar cases we developed a more pro-active framework for studying and managing the co-evolution of technical and institutional change (Figure 2). It is an elaboration of the work on technical change and transitions carried out by Kemp *et al.* (2001; see also Figure 1) and Geels (2002). The institutionalization perspective (i.e., the routinization and socio-material sedimentation of practices) and the interaction between 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 stretching socio-material spaces; going from local practices (this is where the actors are) to the 'world' as a whole. The dynamics along this spatial dimension can be studied for instance in terms of actor-worlds.

The framework can be used as an analytical tool to study and comprehend complexity (multi-actor, multi-level, multi-aspect) of technical-institutional change.

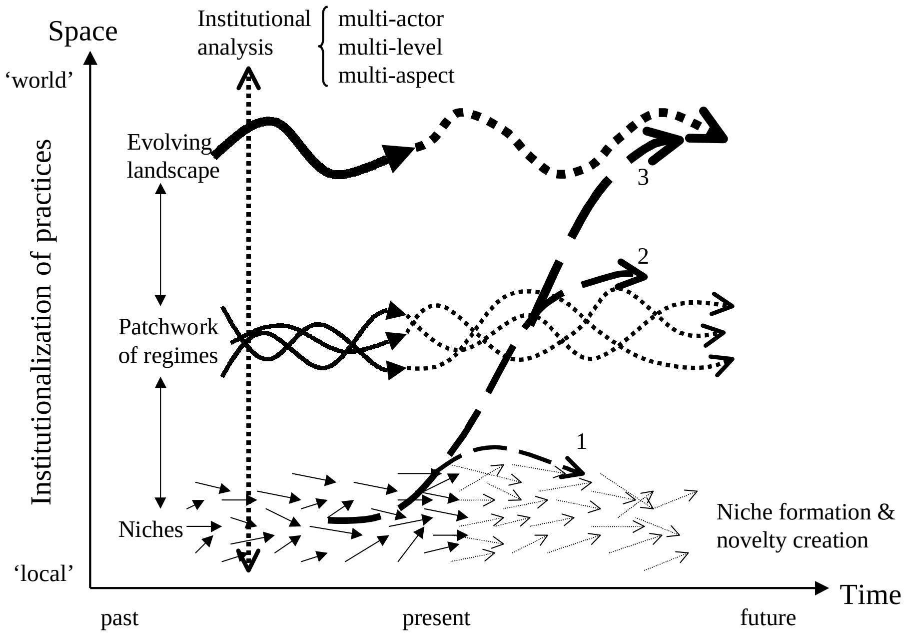

Figure 2. An overall framework for studying and managing technical-institutional design. 1 = no breakthrough of novelties; 2 = system innovation and regime shift; 3 = transition. After Roep (2002).

However, it can also be used as a reflexive tool in order to question oneself: how far is a transition in agriculture and what can we do about it? By way of conclusion we will do the latter. That is, we will make some remarks on how to relate novelty creation, (system) innovation and transition as input for a pro-active management of technical-institutional design processes:

1. A 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 VEL & VANLA niche, a reversal of regimes is still far ahead. As the prevailing modernization regime has strongly dominated for some decades, innovation and transition in agriculture are seriously hampered by the institutionalized incapacity to do things differently (Roep, 2000). This is (willingly or not) obstructing novelty creation and consequently system innovation and in the long run a transition towards 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 organization, is crucial for transition to take off in agriculture.
2. No matter how much we talk or write about it, (system) innovation and transition only take off with bits and pieces of change that are locally produced, with novelties created by innovative actors and that need to be nurtured in niches to develop their potentialities. In pro-active terms this means that innovation and transition cannot but be rooted in promising, innovative practices. This implies that we need to stimulate novelty creation, niche building and smart experimentation and the creation of

communities of practice (building social capital) to explore and evaluate the potentialities of (a connected range of) novelties. These potentialities need to be evaluated at different levels, e.g. at farm level, sector or regional level and society as a whole, because considerations of different aspects of sustainability will differ at different levels, which in turn has an impact on design criteria. In agriculture, taking into account it specificity, 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 later stages of transition (Rotmans *et al.*, 2000). Policy needs to stimulate and facilitate novelty creation and smart experimentation to be able 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 no neutral processes: there is a lot a stake. One can prospect different, competing transition paths leading to different outcomes. The prospected outcomes as well as the prospected transition paths leading to these outcomes will be subject of debate. A management or design tool often used is to project different (visionary) desirable future images and subsequently project possible transition paths going from the desirable images back to the actual 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 cannot be a goal in itself. One cannot simply disregard ongoing dynamics and enforce them, although sometimes some force will be needed to effectuate change. Anyhow, a point-centred, top-down management of innovation and transition, as in the decades of modernization, does not work nowadays.
5. Finally we want to stress again the importance of a simultaneous design of the technical (artifact, machines, systems) and institutional functionalities (rules, roles and procedures) of novel configurations in order to create a more properly working whole. Even if not aware of it, institutional as well as technical engineers are in fact heterogeneous engineers (Law, 1994), i.e., technical engineers presuppose or, often implicitly, design a complementary institutional setting, whereas for institutional engineers it is the other way around. This urges for inter- or even transdisciplinarity as a sound foundation for technical-institutional design.

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