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System Innovations, Knowledge Regimes, and Design Practices towards Transitions for Sustainable Agriculture

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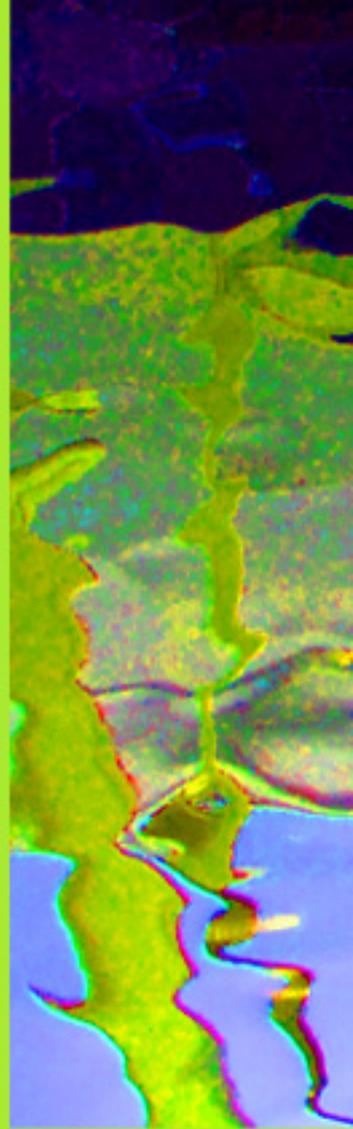
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System Innovations
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and Design Practices
towards Transitions
for Sustainable Agriculture

edited by

Marc Barbier and Boelie Elzen



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Preface

Late in 2009, researchers from ‘Wageningen University and Research Centre’ in the Netherlands (WUR) and the ‘Institut National de la Recherche Agronomique’ in France (INRA) took the initiative to design and organise a special international workshop with the view to bringing research insights and practical experiences together, and to discuss papers in depth in order to form a basis for effective strategies to stimulate a transition towards sustainable agro-food systems.

The main goal was to engage a community of researchers and policy makers in the production of an overview of analytical methods, experiences and scientific insights on the main issues at stake in the sustainability projects and programmes that they were contributing to. More specifically, the workshop was to contribute to:

- comparing and contrasting the issues of analysis and governance of innovation and R&D practices in various European countries;
- providing input for rethinking government policies, socio-professional strategies and civic concerns, with the view to contributing to sustainable development in the agro-food systems on the basis of existing research and experiences;
- defining the content and the agenda of a possible consortium for further research.

Researches were expected to have an analytical component (to analyse the relevant processes) as well as a constructive component, i.e. to play a role in co-operation with other stakeholders in the development of sustainable alternatives covering several agricultural subsectors – animal production; arable farming; glasshouse horticulture; biomass production for fuel and fibre – and to target emerging innovations in agro-food systems, knowledge regimes in transition, or design practices.

Two main issues were proposed to the participants:

- Analyse the dynamics in agro-food systems, including system innovations, knowledge regimes and design practices that are currently ongoing.
- Investigate how government agencies and other actors can organize themselves and what they can do to encourage and influence such system innovations, knowledge regimes and design settings in order to make agro-food systems more sustainable.

Supported by the Dutch Ministry of Economy, Agriculture and Innovation, WUR and INRA, the Wageningen UR Livestock Research Group hosted the workshop in Lelystad in the Netherlands from the 16th to the 18th of June 2010, entitled:

“System Innovations, Knowledge Regimes, and Design Practices towards Sustainable Agriculture”.

A scientific and organizational committee was set up under the coordination of Boelie Elzen that was composed of Barbara van Mierlo from WUR-CIS, Boelie Elzen and Bram Bos from Wageningen UR Livestock Research, Marc Barbier and Marianne Cerf from INRA SenS, and Gilles Allaire from INRA ODR. A call for papers launched through the scientific networks of the committee members and published on the Wageningen UR Livestock Unit web site. About eighty paper proposals were submitted of which 17 were selected for presentation. The format of the meeting was designed to stimulate in-depth discussions of various issues, rather than having many presentations and only brief discussions. To achieve this, the key features were to have plenary sessions based on intensive interactions among a limited number of participants. All participants were invited to play an active role, either as paper authors or discussants or both. Participation to the workshop was by invitation only on the basis of submitted abstracts (for researchers) or known expertise (for policy makers).

The invited participants came from a variety of disciplinary backgrounds such as Innovation Studies, Economics, Science & Technology Studies (including constructive and interactive technology assessment studies), Policy Studies (including studies of network governance, learning and the impact of regulation), Organisation Studies (including studies focusing on management of structural change and leadership) and Practices Based Studies. In addition to disciplinary perspectives, the workshop succeeded in attracting policy-makers and representatives of cooperative and professional networks from Belgium, France and the Netherlands, all of whom brought with them their experiences and own ways of framing insights.

After further review (two reviewers per paper), some contributions were considered mature enough to engage a publication process. We are therefore extremely happy to present a selection of those contributions that have sufficiently evolved to compose the chapters of this book. We wish to thank all the participants for the quality of their contributions, their efforts to improve their papers, and their purposeful comments and advices, which enhanced the quality of all the papers through the reviewing process. We also wish to thank Liz Libbrecht and Nonta Libbrecht-Carey for their remarkable work in helping us to produce an English-language publication thanks to a complete language review. .

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We thank *Wageningen UR Livestock Research* in Lelystad who hosted the international workshop in which authors of the present volume took part. We also thank *Wageningen UR Plant Sciences Group*, *Wageningen UR, Dept. of Communication and Innovation Studies* and the *INRA Research Unit Sciences in Society* for their strong support.

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We cheerfully deliver a special word of thanks to all the colleagues that took part to this enchanting workshop in Lelystad and who improved the quality of the initial contributions of authors through a cross reviewing procedure that has been very stimulating and effective to improve the quality of the present book.

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Introduction

Boelie Elzen¹

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PATHWAYS TOWARDS SUSTAINABILITY

Over the past decade the transition towards sustainable agriculture has been a central theme in the work of many organisations, including government bodies, NGOs, professional organisations and research institutions. Various publications, including White Papers by the EU and different national governments, have defined future targets and objectives to improve sustainability in various subsectors like animal production, arable farming, or glasshouse horticulture. There has also been growing concern about the sustainable use of biomass for fuel, feed and fibres, which became a public issue due to the ethical or economic implications of the multi-functionality of agriculture.

It has become clear that the development of our industrial societies has had serious adverse effects. This is true for a variety of sectors, including the agro-food system (*sensu largo*, that is, including the production of food, feed, fuel and fibres). Although most governments have adopted the notion of sustainable development as a basic policy principle, it is becoming increasingly clear that the achievement of a ‘post-industrial’ society will not necessarily result in a more sustainable society, i.e. a society that is characterised by a better balance between economic, social and ecological goals. Ensuring that any transition potentially taking place does lead to greater sustainability is a major challenge for societies in general and for agro-food systems in particular, one which calls into question the relations between agronomic sciences, agricultural technologies and public or private expectations. Hence, the call for “innovative innovation” to underpin the purpose and design of new technologies and practices or new practices of existing techniques, and which highlights the need for a shift in the governance of research and innovation in order to achieve a sustainable future.

Nevertheless, the transition to sustainable agro-food systems will neither be easy nor straightforward. This is partly due to the extremely complicated nature of the long-term societal changes needed. Such a transition will require the adoption

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and dissemination of new technologies embedded in new economic, social, institutional and cultural relations.

DYNAMICS OF INNOVATION AS A SCIENTIFIC ISSUE

Innovation has been defined as crucial to the transition towards sustainable agro-food systems. This typically implies technological change, for a host of new technologies will be needed to meet the sustainability challenges in the various agricultural subsectors. Technological change, however, will not be enough. The enormous challenges lying ahead will also require new regulations, new behaviours (e.g. of consumers, farmers as well as many other stakeholders), cultural change, institutional change, institutional 'hybridicity' (Allaire and Wolf, 2004), and the ecologization of agricultural sciences and technology (Van Loqueren, Baret, 2009; Barbier, 2010).

While some authors use the term 'system innovation' to denote such broad change processes (e.g. Elzen et al. 2004; Geels 2005), others have developed the notion of innovative design (Lemasson, et al., 2006; 2010) in socio-economic orders or agro-food systems (Aggeri et Hatchuel, 2003). Participatory design and mediation activities in situations of change in R&D systems of activities are one example of innovative design (Beguin & Cerf, 2009).²²

System innovations are multi-factor, multi-actor and multi-level (multi-scaled) processes, and can only be understood through the historical co-evolutionary processes which link up these actors, factors and levels. These historical processes are riddled with uncertainty and constitute open-ended learning processes. Influencing such processes has proved to be difficult, but not impossible. To stimulate sustainable development, the challenge lies in influencing development at an early stage, when irreversibilities are not yet entrenched and one can hope to sway the balance between desirable and undesirable development processes. Researchers on system innovation, knowledge regimes and design practices in the agro-food sector can be seen as pivotal examples of what Gibbons et al. (1994) called a mode 2 type of knowledge production. It transcends traditional disciplinary science in two ways, viz: (1) it combines insights from various disciplines and (2) knowledge is generated in a combined effort by scientists and stakeholders from the domain under investigation. However, following the debates about the Mode 1 – Mode 2 model (Pestre, 2003), researchers and practitioners have become aware that more knowledge about those dynamics is needed and more expertise is required to make headway. This is why a joint effort by European researchers, policy makers and strategic actors from the agro-food sector is crucial to reflect, compare and design elements of the roadmap towards sustainable agriculture.

This initiative is underpinned by a classic approach to technical and societal change, viewed as closely intertwined and forming a seamless web (Hughes 1986). Many authors argue that any transition to sustainability will involve a

high level of social-cultural change coupled with equally profound technological change and, in parallel, extensive global or local social debates about how to design the future and bring about system innovation. From a general perspective, system innovations are defined as major changes in the way societal functions such as food production and consumption, energy use and supply, transportation, etc., are fulfilled. Such changes typically involve the co-evolution of a number of related elements, including technology, infrastructure, symbolic meanings, governance structures, scientific knowledge, industry and related institutions, etc. The need for system innovations that lead to more sustainable development paths has been recognised in various policy networks and research programmes. This affects not only the agro-food system but a variety of other systems as well, e.g. the energy and transportation systems. Over the past decade, this has led to the production of significant insight into innovation processes, as well as practical experience in attempting to stimulate system innovation towards sustainability (e.g. Voss et al. 2006; Grin et al, 2010, Darnhofer et al. 2012).

It appears, however, that there is a considerable mismatch between the general insights developed in research and the more detailed practical issues that are at stake in concrete projects and programmes. As a result, it is far from clear how to set up projects and programmes to contribute to system innovation for sustainability. (e.g. Elzen et al. 2012) One reason, identified by historical studies, is that system innovations can take a long time (of the order of decades) and rarely result from a single new development. Instead, they stem from a long process of combination and re-combination of novelties from different sources. This calls for a comprehensive and reflexive understanding of shifts in knowledge regimes and design practices.

PARADIGMS OF SUSTAINABILITY

The concept of sustainable agriculture holds very different meanings to various parties: this seems to be one of its fundamental characteristics. Some stakeholders in existing agro-food chains may argue that various sectors are already largely sustainable as it is, and that only small and incremental improvements could make systems go “green”. Others, especially NGOs and certain groups of researchers, have been arguing for a long time (Mol, 2000) that, in order to achieve what they call ‘integral sustainability’, a complete overhaul of existing farming systems is needed: transition thus means major changes. The idea of integral sustainability refers to a system that satisfies various dimensions of sustainability at the same time, i.e. climate neutral, pollutant free, economically feasible, acceptable working conditions for farmers, publicly and politically acceptable, and, in the case of animal production, good animal health and animal welfare.

These two visions represent two different paradigms, which have given rise to two different roadmaps on how to move towards sustainable agriculture

(Levidow et al., 2012). Within the dominant paradigm, the Knowledge-Based Bio-Economy (KBBE) roadmap promotes the role of the life sciences in techno-scientific development as a means of achieving a more efficient use of renewable resources. While this route could indeed lead to sustainability gains, it could also potentially (further) turn agriculture into a factory-like undertaking requiring capital-intensive inputs, while effectively marginalising farmers' knowledge and innovations. Alternative approaches are being conceptualised and promoted as Agricultural Knowledge Systems (AKS). This articulates a co-research relationship between all relevant knowledge-producers, including farmers. One example is the agro-ecology research agenda, which would extend farmers' knowledge of local resources (Altieri, 1995).

The KBBE paradigm strongly relies on technical innovation, with little attention being paid to behavioural or institutional change. However, this is based on a potentially very risky simplification of likely future developments, which assumes the alignment of actors with few controversies or network changes. Historical studies of innovation processes show that major technical innovations always go hand-in-hand with behavioural and institutional change. One example is the development of the PC and the Internet, which drastically changed a broad range of production processes and even people's private lives. Relying (too) strongly on the KBBE paradigm thus entails the risk of leading to new institutional arrangements, which, in due course, may be considered very problematic and unsustainable. Possible examples are new ownership relations and decision-making processes surrounding the distribution of food products, new health hazards because of new micro-organisms or new channels of dissemination of such organisms, changing North-South relationships, etc. At the same time, the KBBE paradigm is by far the dominant one, as evidenced for instance in the EU FP7 programme or the European Technology Programmes (ETPs). This dominant framework also has an impact on knowledge regimes in the life sciences (Vanloqueren and Baret, 2009)

This is problematic, given the ambiguity of the term sustainability, as indicated above. In general terms, this ambiguity can be addressed through two broad approaches, namely:

- Reducing the ambiguity by setting stricter definitions;
- Accepting the ambiguity and bringing together multiple parties with divergent views to deal with the complex and socially contested issues surrounding sustainability.

Given the disagreement on the meaning of the term sustainability, the first approach is very problematic. Scientific research may provide part of the answer by using well established methodologies to analyse specific problematic issues but many other sustainability issues are largely related to stakeholders' viewpoints and hardly lend themselves to scientific scrutiny, except to analyse these stakeholders' opinions.

The AKS paradigm is better equipped than the KBBE paradigm to deal with the ambiguity of the meaning of sustainability, since it explicitly seeks the

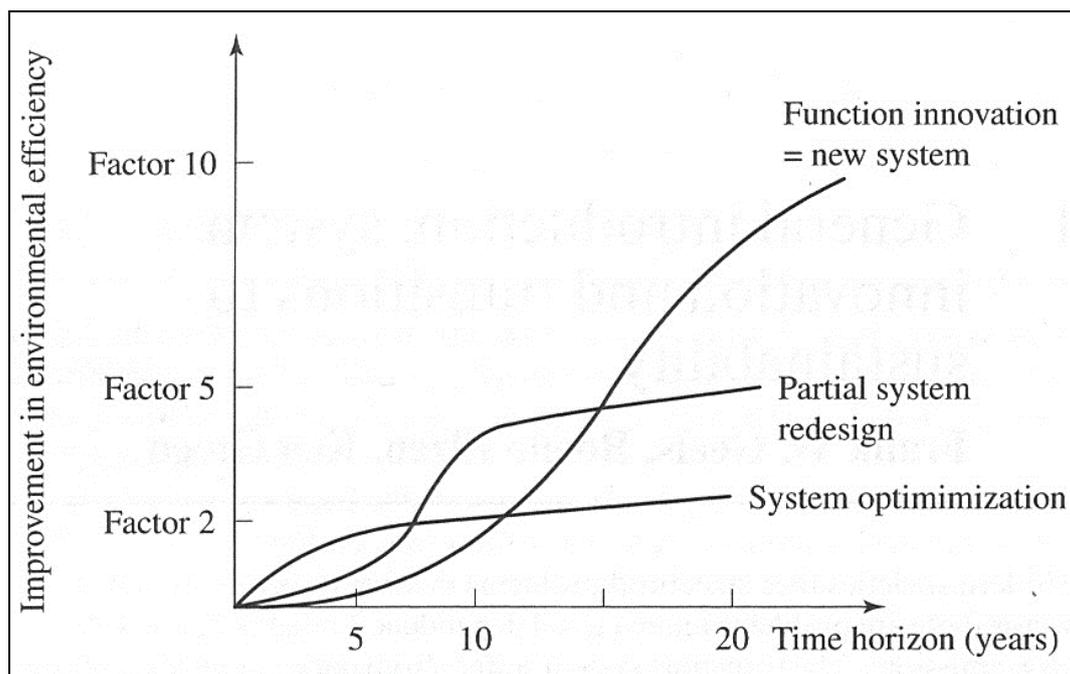
involvement of a variety of stakeholders in its explorations and research. Given that the KBBE paradigm is currently the dominant one and may also pose serious risks, it would be wise for policy makers to pay greater attention to the AKS paradigm. This implies that there should be more support for research programmes, projects and sector initiatives based on such approaches.

SYSTEM OPTIMISATION VERSUS SYSTEM INNOVATION

The differences between the KBBE and KBS paradigms reflect a distinction between two different patterns of innovation. The first relies heavily on technical change, whereas in the second a large role is also played by organisational and institutional change. In innovation research, these two patterns are identified as system optimisation and system innovation. System optimisation essentially attempts to remedy problems within existing systems using add-on solutions, e.g. cutting emissions. System innovation, by contrast, may involve completely redesigning an existing system. It not only involves new technologies, but also new markets, user practices, regulations, infrastructures and cultural meanings. Innovation thereby takes on a much broader meaning than mere technical renewal. Indeed, in many cases the non-technical changes may be much more radical than the technical changes.

This distinction is particularly relevant for those seeking to stimulate innovation towards sustainability. On the one hand, system optimisation is considerably easier to achieve, as less change is needed. On the other hand, the potential for system innovation to improve sustainable performance is much greater (Weterings et al., 1997).

Figure 1. The sustainability promise of system innovations (Weterings et al, 1997: 18)



Given its promise of sustainability, there is increasing interest from policy makers, NGOs and large firms in transitions and system innovations (see e.g. VROM, 2001; Raskin et al., 2002). This does not mean, however, that system optimisation has become irrelevant. Figure 1 illustrates that while system innovation (called function innovation in the figure) may have greater potential it tends to take longer to produce results. It may therefore be wise to follow strategies and policies that encourage both.

This begs the question: how can this be achieved? Before turning to these discussions, however, we first present an innovation model that can help us understand the differences between the two forms of innovation, the so-called “Multi Level Perspective” (MLP). Many of the papers presented at the workshop used this model and various aspects of it are addressed in the sections below.

THE MULTI-LEVEL-PERSPECTIVE (MLP): A TOOL TO HELP UNDERSTAND DIFFERENT PATTERNS OF INNOVATION

The MLP distinguishes three levels in innovation processes (Kemp, 1994; Schot, Hoogma and Elzen, 1994; Schot and Hoogma, 1998; Kemp, Rip and Schot, 2001; Geels, 2005):

- The meso level of ‘socio-technical regimes’. This denotes an existing socio-technical system, e.g. the glasshouse horticulture system or pig husbandry system. Such systems are embedded in society and are linked with a wide variety of societal actors (e.g. companies, public authorities, users/consumers).
- The micro-level of ‘technological niches’. This denotes protected spaces in which radical innovations are developed. Niches are an important learning space for issues like technology, user preferences and practices, regulations, etc.
- The macro-level of ‘socio-technical landscape’. This denotes the ‘external environment’ and consists of factors that affect not only the regime under analysis but a variety of other regimes as well. Examples are the need to curb CO₂ emissions or the emission of pollutants.

The relationship between the three concepts can be understood as a nested hierarchy, which implies that regimes are embedded within landscapes and niches within other regimes (Geels, 2002). Using this model, the two different patterns of innovation can be conceived of as follows:

- System optimisation: The socio-technical landscape exerts pressure on the regime to change, e.g. to reduce various emissions or to improve animal welfare. While this tends to be met with initial resistance, it gradually leads to innovative activity within the regime. As a result, technical as well as societal or behavioural change starts to take place in the regime, but is

usually of an incremental nature, building on the system as it was before. In this process the niches play only a small role or no role at all.

▪ **System innovation:** Where pressure is exerted on a regime, the actors within it will often resist, for instance by claiming that the required changes are 'unrealistic'. Conversely, 'outside' actors in niches may see the pressure as an opportunity rather than a threat. They may work on more radical solutions in a variety of niches and learn how to make them work, technically as well as in the framework of consumer requirements, markets, regulations, etc. If successful, these developments may link up to an existing regime and gradually change or replace it, which can eventually lead to system innovation. In this process, niches therefore play a crucial role.

The multi-level perspective has been used convincingly to describe, reconstruct and analyse a variety of historical cases of system innovation (e.g. Geels, 2002, 2006). The challenge is also to draw inspiration from it to stimulate developments towards sustainability, in the agro-food sector as well as in many other sectors. Since this sector is particularly affected by a large number of major issues (food provision, biodiversity, environmental protection, etc.), it provides promising ground for case studies and reflection about the key articulations between: the transformation of institutions in the agricultural knowledge system; the socio-technical features of food production and supply and ecosystem services; and the politics of criticism and expectations regarding the orientation of the life sciences and biotechnology. It can allow us to reflect on the notion of 'regime', and articulate our understanding of agency and structure within specific transition pathways that would be driven by sustainable development (Geels and Schot, 2010).

TOWARDS LEARNING, REDESIGN AND CHANGE

A better understanding of these issues is much needed, given the current de-sectorialisation of many system innovations fuelled and framed by the last modernisation process in western agriculture. But the challenge researchers face is not just about knowledge acquisition, since the way we might understand those transitions is clearly framed by our professional attachment to the very field of practices where the transitions take place. The issue of understanding transitions therefore raises many questions about the governance issues that lie at the heart of structuration pathways (Grin, 2010). Studies of the agricultural crisis and environmental challenge in the 1990s clearly highlighted the need for change in and around agricultural practices (Cerf et al., 2000). This necessitates an explicit learning process and learning resources are acutely needed in order to enable change and support the governance of change. (Elzen et al. 2012)

To understand and thus improve the quality of learning processes needed to enable the transition, R&D professionals in agri-food systems need to become involved in the "making of the transition", and therefore play a reflective role

between niche and regime. Rethinking the ergonomics of activity systems in innovation processes is at stake and calls for an epistemic turn in workplace studies of design (Beguin and Cerf, 2004). This reflects the need to bring back human development within situation of change in studies about transition. But it also means to reintegrate human actors as co-designers of their development in transitions, since innovative activities do not follow the sudden appearance of surmounting “good ideas” but could already be there within the workplace.

These issues are also relevant for the studies of innovation processes and scientific experiments. The relationship between niche and regime might also mean a conflagration of civic epistemology and the design of biotechnological trials, which could entail conflict in the confrontations between research practices and workplace situations in the area of technology assessment (Marris et al., 2008). Alternatively, it might provide balance through dialogic reflection about difference and interests in the design of a sustainable agro-food system open to civic scrutiny (Bos and Grin, 2008).

Reflexive governance (Voss et al., 2006) is also a matter articulating the roles and positions within governance structure with a view to enhancing or developing relationships between the levels of transition. Thus while a lot of the scientific literature focuses largely on specific situations at the niche level, the dynamics of system innovation also implies that niche developments should tie into regime developments in order to have a wider impact.

THREE PARTS OF THIS VOLUME

This volume is divided into three parts. The first part, called “**Alternatives to industrialised agriculture**” contains four chapters that describe on-going processes of change within, or aside, the socio-technical regime that we have inherited from the modernisation and industrialisation process of agriculture, which took part after the second world-war. The focus in this part is on studies dealing with the issue of agro-ecological initiatives born in niches of organic movement, which are questioning the mainstream regime of industrialised agriculture.

A second part is called « **Intervention and Design** ». **The four chapters in this part describe how** researchers participated in situations of change. These studies use different approaches and methodologies, but first of all shed light design, re-design or co-design in change processes in different situations. Trying to facilitate projects that purposefully address sustainability transitions, these chapters provide new insights in ways of doing research and producing scientific knowledge that would not have been possible without such interventionist research practices.

The final part is called « **Innovation with Promise** ». **It contains** four chapters with case-studies of (socio-technical) innovations that hold a promise to induce a transition towards a more sustainable agriculture. The emergence of novelties in

various domains of an existing field of practice (the political sphere, the food or fibre value chains or the more local initiatives) calls for the capacity of collectives to sustain discourses, scopes and transformative arrangements in long term strategies. These chapters propose new frameworks and rationales to understand the discourses, practices and performative promises of sustainability transitions.

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PART I

Alternatives to industrialised agriculture

Chapter 1. New identities, new commitments: something is lacking between niche and regime

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Abstract

This paper analyses the difficulties in achieving the alignment of actors playing different roles in innovative processes. In so doing it seeks to further our understanding of transitions towards sustainable agriculture. We use an analytical framework that combines the Multi-level Perspective with the Actor Oriented Approach in order to examine the emerging ‘novelties’ generated by family farmers producing medicinal plants in ecological systems in the South of Brazil. We identify the characteristics that fit a definition of ‘innovation niche’. We describe the main weaknesses preventing the complete emergence of a niche, and analyse the misalignment of the various actors’ expectations. This is partly due to the incumbent regime’s strong relationship with the dominant technical-scientific fields, which contrasts with ecological agriculture that is known for its remarkable connection to social, technical, organisational, and behavioural changes. The novelty production of medicinal plants clearly illustrates some of the broader transitions at work in rural development. The case study also highlights the importance of finding ways to effectively manage these ‘niches of innovation’, in order to strengthen the internal coherence of their socio-technical dynamics and to reinforce the social networks. As part of this process, there is a clear need to institutionalise new professional identities that are willing and able to question and even disrupt existing commitments.

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1. INTRODUCTION

Sustainability in farming activities is not only a goal to be achieved; above all, it must be seen as a learning process. Amongst other things, this process requires giving back to the technique its original social component, which has often been lost along the way through the trajectory of agricultural modernisation. Yet despite general consensus about the negative impacts of agricultural modernisation, society and science are still a long way from finding the answers needed, and transitions toward more sustainable development could still head in unexpected directions.

The loss of the social dimension of agriculture has two main consequences. The first is the separation of farming from the particular and heterogeneous socio-material environment in which it is situated, and the subsequent weakening of the co-production processes that exist when the two are closely intertwined (Ploeg, 2003). The second consequence is the very strong institutionalisation of agricultural modernisation, which is seen as the only and self-evident development trajectory (Roep and Wiskerke, 2004). The unquestioned superiority of agricultural modernisation has also had the effect of delegitimising alternative options, routes and policy objectives, seen as unacceptable because they are at odds with the self-evident (*ibid.*).

The inequalities that have resulted from the modernisation process, especially in less developed countries, have created a myriad of situations and contingencies which have led farmers to innovate. They do so for a range of reasons, often economic but also frequently rooted in ecological consciousness and/or political engagement. Farmers support and network with other actors, to varying degrees, in order to creatively find new ways of producing, creating alternative markets and empowering themselves. Yet while farmers are experimenting with new ways, it is important not to forget that the modernisation regime is institutionally incapable of doing or seeing things differently.

If one wishes to move beyond simple and limited responses to the agrarian crises (*i.e.* to move beyond seeking to adapt technologies that meet the imperatives of a narrow sustainability – the ecological modernisation approach – or attempting to simply include marginalised farmers in conventional markets) it is very important to recognise the multitude of local initiatives as a source of potential change. This is particularly true in countries like Brazil where farmer-led innovation is driven not so much by the need to reduce pollution or use less inputs and energy, but by the imperatives of achieving food security and reducing poverty. This means that local initiatives may well follow different technological pathways. At the same time, local initiatives are crucial for social learning to take place and for sustainability to be legitimised as a societal goal.

Ecological farming often embodies many of these sources of potential for change. The development of ecological production systems involves practices that are considered deviant in conventional agriculture, which favours practices and

knowledge that call for an extensive use of inputs (agrochemicals, energy etc). Ecological farming shares a different goal, achieving sustainability in farming, even though it is expressed in a number of ways that differ slightly from one another (in Organic, Biological, Natural or Biodynamic Agriculture, and even Permaculture - as well as the practices associated with local and traditional knowledge). The common features that characterise sustainable agriculture include: nutrient recycling, promoting atmospheric nitrogen fixation and improving soil biotic regulation; managing the agro-ecosystem, with an emphasis on soil, water and energy conservation and increasing agrobiodiversity; reducing the use of external inputs, especially non-renewable ones; integrating local and technical-scientific knowledge and practices together; promoting trust and interdependency between farmers and urban and rural populations [adapted from Pretty (1996) and Gliessman (2000)].

The emergence of this agriculture is not only based on the creation of new products or alternative food chains, but also involves the construction of different social configurations, and requires new patterns of learning and the enrolment of many different social actors. In this sense, the evolving practices surrounding the production, processing and distribution of medicinal plants represent an intriguing manifestation of 'Novelty Production'. Novelty Production is a key term for describing the emergence of something new: a new practice, a new insight, new artefacts, innovative social or institutional arrangements and so forth (Ploeg et al, 2004). However, while many novelties have the potential to contribute to the global transition towards sustainable development, they remain relatively isolated or hidden. Our first objective in this paper is to highlight the novelties that have emerged from this 'dissident' form of agriculture.

The second general objective is to propose a complementary combination of two approaches, by providing a multi-level, multi-actor and multi-aspect analytical framework that integrates structuralist elements from the Multi-level Perspective (Geels et al., 2004) and constructionist patterns from the Actor Oriented Approach (Long, 2001). Using this framework we explore the emerging novelties generated by family farmers producing medicinal plants within ecological systems in Southern Brazil. The empirical research is based on an in-depth qualitative study, which includes five cases of family farmers from different locations in the states of Santa Catarina and Rio Grande do Sul (in the South of Brazil). Complementary interviews were held with eleven scientists who work with medicinal plants. We also analysed reports and speeches from seven different technical-scientific events about medicinal plants at national and international level.

While investigating the novelties and associated learning processes and social relations, we recognised some characteristics reminiscent of an 'Innovation Niche' (Kemp et al, 1998; Wiskerke, 2003). We also observed the difficulties involved in establishing a complete innovation niche for medicinal plants – despite the presence of dynamic local innovation. The main purpose of this paper

is to analyze the constitution of this niche, and identify the barriers to fully developing a protected space for it.

We begin by setting the scene at the location where the work took place. We then outline the theoretical approach which guided the empirical research and which orientates the discussion. The analysis is threefold. The first part describes the elements characterising the construction of the promising innovation niche, particularly the novelties involved in producing medicinal plants within ecological systems. The second part reflects on the processes required to change actors' identities and their established commitments towards the agricultural regime. The third part looks at the gaps that exist between the niche and regime levels, which might influence processes of structural disruption associated with socio-technical transitions. Finally, we draw some conclusions on the broader significance these findings may have.

2. SETTING THE DEBATE

Agrarian studies are underpinned by the notion that 'technical progress' is the way to overcome natural obstacles in order to enable the capitalisation process in the agricultural sector (Graziano da Silva, 1981). In Latin America (and Brazil in particular) this notion, together with diffusionist ideals (Rogers, 1958; Schultz, 1965) and the "Induced Innovation Theory" (Hayami and Ruttan, 1978), has unquestionably influenced the research, teaching and rural extension systems.

During the 1970s the Brazilian government pursued agricultural policies that provided credit, guaranteed prices and investment in research, supporting what is now known as 'conservative modernisation', a trajectory that deepened existing social and regional inequalities (Gonçalves Neto, 1997). As in other parts of the world, this model of agricultural modernisation had significant negative impacts on the quality of soils, water and biodiversity as well as the health of rural and urban populations.

Brazil is a vast country with huge ethnic, cultural and ecosystem diversity. As such, responses to modernisation vary and may have the potential for providing important new blueprints for sustainable development. Yet agricultural innovation still remains geared towards becoming more competitive by promoting modernisation, for instance through the introduction of genetically modified organisms or even 'greening' agricultural export commodities. In such a context one can raise questions about the extent to which the institutions involved in research, teaching and rural extension will be able to comprehend the country's social and natural diversity and develop appropriate strategies to support a transition towards sustainable development.

Critics of innovation in the Brazilian agricultural system adhere to two main streams of thought. The first comes from neo-Schumpeterian inspiration: it recognises weaknesses in the 'demand-pull' and 'technology-push' models, but

limits its proposals for institutional change to making adjustments that will better meet changing production and market needs. The second has non-specific theoretical underpinnings but generally highlights the need for paradigmatic changes, which recognise that sustainability requires more than market-led development, and rejects the positivist episteme of science as the single guide for innovative activity.

The controversial issue of the adequacy of technological innovation to meet the sustainability challenge stems not only from the inherent limitations of a top-down approach, but also from the absence of interaction with society at large. There are many social aspects to innovation (production and consumption, technology, policy, government). Rotmans and Kemp (2003) claims that changes in the direction of innovation are fundamentally contingent on technological breakthroughs with unidirectional science-to-practice models. Poel (2000) takes this further, advocating the need for innovation to involve new actors, previously considered insignificant, as they are external to the institutions that specialise in research and development.

It is also important to remember that the production of novelties by farmers (and other related actors) is linked to the development of practices that combine the material, social, symbolic and institutional realities embedded in existing patterns of socio-technical interactions at various levels (Ploeg et al, 2004). Kemp et al. (1998) argue that, innovating, creating conditions for the emergence of novelties, changing behaviour and consolidating these changes at different levels involves a dynamic that must first and foremost be understood as a 'learning process' in which numerous actors are engaged. But it is not always clear how to bring together these different actors, who belong to different 'worlds' and speak different 'languages'. Establishing and managing such encounters is one of the biggest challenges for developing new technological practices or establishing a distinctive system of innovation within agriculture.

3. INTEGRATING DIFFERENT THEORETICAL APPROACHES

As there are several promising pathways to (re)-grounding technology in society, it is important to identify and analyse the structural aspects (*e.g.* from landscape level) in order to establish general inferences about the evolution of technological phenomena. However it is also important not to lose sight of specificities, localities, actors' protagonisms and knowledge contextualisation. However, the analysis of inter-relations at different social levels usually only focuses on administrative rules and procedures, showing, for instance, the ways in which they shape the work of organisations (Long 2001). Moors et al. (2004) suggest that the interactions between technology and society can be better analyzed by adopting a multi-level, multi-actor and multi-aspect approach.

This approach takes the view that innovative processes are mobilised through co-evolutionary dynamics that emerge from the interaction of nature, techniques

and institutions. These dynamics work at different levels and influence the feasibility and socio-technical stability of innovations. Agency plays a key role here. This approach is a combination of two different approaches, which share a number of common assumptions: the Multi-level Perspective (MLP) and the Actor Oriented Approach (AOA). Both perspectives consider agency to be multi-dimensional, with actors having their own interests and acting strategically, but also being constrained by embedded social structures.

The Multi-level Perspective adopts an interdisciplinary approach to describe socio-technical changes, and is strongly influenced by evolutionary economics, neo-institutionalist notions, and Giddens' theory of structuration (1984). According to Geels (2004:33), this approach "sprouts from a combination of sociology of technology and evolutionary economics" which seeks to explain technological transitions through the use of three different analytical concepts: the innovation niche, the technological regime and the socio-technical landscape. A niche can be defined as a specific domain within which actors take risks. Innovation (or technological) niches are deliberately created by the actors involved and are supported by specific institutions and rules that limit or guide actions, and that may be regulative, cognitive and normative (Geels, 2004).

Kemp et al. (1998:182) have defined a technological regime as a "whole complex of scientific knowledge, engineering practices, production process technologies, characteristics of the products, skills and procedures, institutions and infrastructures that make up the totality of a technology." Since it involves many social groups with common rules and a shared grammar that guides and provides stability to the whole socio-technical system, Geels (2005) argues that it is possible to think about a socio-technical regime as a semi-coherent set of rules held by actors linked to different meta-coordinated regimes (technology, science, market, socio-cultural and policy).

The broadest level is the 'landscape', representing the whole background of variables, factors and processes that influence the technological transition and consequently the regimes and the niches. The degree of social and institutional structure increases from the micro level (niche) to the macro level (landscape) (Geels and Schot, 2007).

The Actor Oriented Approach (AOA) stems from a long tradition of empirically based studies in the anthropology of development and rural sociology, and it is centred on the notion of human agency, which posits that actors (individual or collective) have a certain capacity for processing social experiences and responding to problematic situations. AOA has often focused on 'knowledge encounters', seeking to overcome dichotomised representations of different forms of knowledge (*i.e.* modern science *versus* popular science; exogenous *versus* local knowledge) (Long, 2001). This approach highlights the relevance of discourses that incorporate metaphors, representations, images, narratives and affirmations, which guide the truth on objects, people, events and their inter-relations. These discourses produce texts which may be written, verbal or non-

verbal, and which bestow meanings upon infrastructure, technologies and styles of agriculture (Long, 2001; 2007).

The study of 'novelties' in agriculture could therefore be furthered by including theoretical-methodological approaches that recognise the importance of articulating and enlarging learning processes, particularly in light of what Long and Ploeg (1994) called the multiple aspects of the social life of rural development and the corresponding cognitive processes involved.

In practical terms there is potential for locally developed innovation processes and technology choices to be a driver of technological development at a broader societal level. To a certain extent, this assumption puts agency back at the core of dynamics of socio-technical change. This can be better understood by examining how actors support the niches they are involved in. There are many aspects to this process, including the relations between actors and their networking capacity, the cognitive processes involved in practices and in novelty production and the establishment of new rules and institutions. However the exercise is not purely academic – the key objective is not to search for patterns in the construction of niches. It has a more practical focus: to understand how to create more sustainable and innovative spaces.

Insights from socio-technical transition studies suggest that the micro level of action in innovative processes is the main *locus* of regime change, mainly because there is less structuration at this level (Hoogma et al, 2002; Berkhout et al, 2004; Geels and Schot, 2007). But it is important to stress that the extent to which even successful niches can be effectively adopted at a broader level is limited. Geels and Schot (2007) mention that one more frequently finds a multiplicity of reactions between niche elements and regime components. Moreover, Smith and Stirling (2008) point out that regimes can co-opt elements of a radical niche into an incremental process of change.

Geels and Schot (2007) argue that niche-regime relations can perhaps best be analyzed through the prism of social theories with a stronger focus on the specific causal mechanisms involved. Smith et al (2010) reiterate this point, stating that in empirical settings the distinctive boundaries between niche and regime are not as clear as MLP implies. These authors stress that more research targeting the micro level is needed, as well as better awareness of the fact that the incumbent regime may not be as homogenous as is generally assumed and that a self-evidently sustainable niche is encompassed by broader complex reality.

Hence analytical MLP constructs contribute to developing a deeper understanding of the structural change processes involved in technological development by addressing the interrelations between different levels. AOA provides a complementary approach, which emphasises the need to understand the cognitive processes that emerge from actors' actions, struggles and networking. An integrated approach to analysing innovative processes in agriculture thus appears to be fruitful.

4. A NICHE UNDER CONSTRUCTION

The global demand for medicinal plants is steadily increasing as natural products become more popular. In the case of Brazil, there are also long-standing traditions of utilising such plants, and public policy is now supporting the introduction of phytotherapy within the public healthcare system. Since 2006 Brazil has had a National Policy on Integrative and Complementary Practices, which embraces the implementation of a National Programme for Medicinal Plants and Phytotherapeutics (Brasil, 2006b). There are many reasons to expand the cultivation of medicinal plants (including obtaining quality assurance and measures to control excessive wild harvesting). However, these 'new crops' are unusual farm products and their domestication and/or cultivation presents several particularities that require significant innovation.

Usually, improving agricultural processes is a matter of increasing biomass production (especially when driven by the principles of modernisation). But with medicinal plants the aim of cultivation is to obtain the active ingredients, which are usually produced by the secondary metabolism of the plants. This means the issue of how to manage (or how to research) these crops needs to be thought of differently. Another difference is that there are thousands of medicinal plant species; most of them not domesticated. Taking an interesting plant from nature and turning it into a standard crop is not a simple matter. Moreover, this huge range of biodiversity is associated with traditional and/or local knowledge held by many different social groups, further complicating the search for innovation. Despite advances in pharmaceutical research and a lot of effort from specialised but isolated groups in agrarian research institutes and universities, there is as yet no nationally coordinated approach to develop the potential of this sector.

Without any off-the-shelf technical package for cultivating medicinal plants ecologically, farmers have sought solutions and produced novelties based on contextual knowledge, building on their own practices and a dynamic learning process that flows through networks created using their social links. These networks have emerged from farmers' involvement in social and ecological movements, alternative markets, healthcare programmes, communitarian services and (formal and informal) education activities. From this point of view the ecological production of medicinal plants can be considered a 'novelty', generating a number of other interrelated novelties.

The novelties developed by farmers include an assortment of soil management and cultivation systems, the development of special drying and packaging methods, the establishment of local partnerships for processing the products, the continuous introduction of new species and varieties, and the creation of alternative channels of trade and non-farming activities, such as the integration of these activities into rural tourism routes. Each of these novelties has an impact and generates a response, combining elements such as biodiversity, technology, symbolic values, work, organisation, knowledge and economic value. The

only be a small change in some agricultural technique, the relationships themselves are novel, because they do not correspond to the conventional path of technology generation and diffusion.

The families who collaborated with the study are pioneers in cultivating medicinal plants within an ecological system in the south of the country. The analysis of their trajectories shows that they have been inspired by distinct motivations. They commonly reject conventional agriculture, create numerous innovation strategies, and broaden their spaces of autonomy, so as to be able to maintain their 'rural lifestyle' and preferred way of carrying out agricultural activities. Such strategies go beyond optimising and recombining production factors: the farmers seek to establish a new nexus and new alignments between distinct blocks of knowledge, expectations and institutions in their quest to produce medicinal plants.

Some farmers working with medicinal plants are involved in different social movements, for instance, the *Movimento das Mulheres Camponesas*³ (MMC), a Brazilian group with a strong feminist and socialist perspective; and the *Movimento dos Trabalhadores Sem Terra*⁴ (MST), a group struggling, since the 1980s, for comprehensive land reform. More recently these movements have adopted the sustainability discourse and are now explicitly oriented towards agro-ecology. Both movements are part of *Via Campesina*⁵ and, as such, are aligned with other like-minded movements around the world: they seek political alternatives to neoliberal globalisation and, in practical terms, build creative spaces to develop agriculture's endogenous potential (Sevilla Guzmán and Martínez-Alier, 2006). The contact with, and participation in, these broader movements has enabled the farmers to create local spaces for action and collective learning, as well as affording many opportunities to develop new social ties with different actors.

An interview with one family illustrates the interrelation between political and productive activities and the family's multiple engagements with such movements: "*we are fighters, we took over the land through our engagement in MST that goes back eight years, but we were ecologists before that*". They are based in the extreme south of Brazil, in a region historically dominated by extensive beef cattle production on very large ranches. By contrast they have a plot of 24 ha, where they manage more than 120 different plant species, producing dried plants to sell as tea or as raw material for the small-scale production of hygiene products (shampoo, soap, moisturiser, etc.). One of their marketing channels is the MST network of shops, established in three big Brazilian cities, where they can sell their tea bags under the MST label.

Another example is the trajectory of a farmer from Santa Catarina, who began to work with medicinal plants in communitarian services linked to the Catholic

³ Peasant Women Movement.

⁴ Landless Workers Movement.

⁵ An international movement of peasants, small and medium-sized producers, landless, rural women, indigenous people, rural youth and agricultural workers.

church. After her engagement with the rural women's movement she, together with other neighbours and with support from the movement, founded an association and set up regular meetings to exchange information and "*to learn together*". Later, they integrated extensionists from the state service and teachers from the local university "*to help out*". Justifying the invitation she said: "*it was necessary to carry out the botanical identification; it's important to know and it's a requirement to sell the teas*".

This led them to get a stall to sell the medicinal plants (and other farm products) in a local market-place, inside the university campus, thereby generating income for their families. The purpose of this group is not just to develop a profitable activity, but also to provide plants, remedies and information about basic healthcare to other groups, networking with different actors. This farmer's personal knowledge and practical experience led her to work in an official healthcare programme together with physicians and pharmacists. This amplified existing social links and created new ones, as well as possibilities to exchange knowledge. This small fragment of one farmer's trajectory highlights how new social configurations, which involve the actors networking and encountering different forms of knowledge, are at the source of novelty production.

We followed the farmers' daily activities, which allowed us to observe their other engagement, for example with urban consumer movements. Three of the five families began their commercial activities with medicinal plants through their involvement with the *Cooperativa Coolméia*, a cooperative that brings together consumers and farmers to create alternative chains for ecological products in Rio Grande do Sul. Since 1989, the farmers have been commercialising medicinal plants through face-to-face markets – one of the current market places receives over 5,000 visitors every Saturday. Their customers and visitors include teachers, researchers, students, public agents, politicians, etc. The farmers recognise the value of these encounters, which create social links that are valuable for exchanging knowledge, mobilising resources, accessing public policies and, in some cases, collaborating in research activities.

The empirical evidence shows a rich set of social relations between multiple actors, which sometimes generate networks. These actors sometimes create linkages between fields of action such as emancipatory movements, the technical-scientific domain, health care programmes and organisations of farmers, consumers and environmentalists. These overlaps seem to provide the conditions needed for the emergence of an innovative space that supports the ecological production of medicinal plants. However, considering that space as an innovation niche does not mean it is a project that has explicitly defined and common goals, shared by all the actors involved. Here, following Geels (2001:5), the niche is understood as an analytical concept to describe socio-technical dynamics, not as an ontological description of reality or a functional and well-defined part of a system.

Projects conducted through 'Strategic Niche Management', with a wide empirical base, will generally refer to experiments conducted under shared agreements by

distinct actors. Such experiments need not be limited to strictly delineated and scientifically structured approaches for assessing statistical significance or establishing the value of a pilot project. The most significant feature of this experimentation is that it takes into consideration users' needs, social benefits, negative effects and regulations (Hoogma et al., 2002). Testing, in this case, should be seen as a learning process in which the potentialities of a novelty are articulated and accepted (Wiskerke, 2003).

Such experiments emphasise dialogue between scientists and farmers (sometimes even state public agents) and, most of the time, relate to a specific location or region (Wiskerke, 2003; Stuiver, 2008). Technological innovation niches are usually protected spaces that have been deliberately created, where innovations can be "nourished" until they become sufficiently "ripe" (Hoogma et al., 2002). For Wiskerke (2003:432), "developing a niche means exposing the novelty step-by-step to real-world conditions".

The case studies on which this paper is based do not exhibit any deliberate efforts to protect a space for innovation. Yet it is possible to observe some alignment between strategic expectations and engagements that allows us to catch a glimpse of the emergence of the innovation niche. The farmers' capacity for innovation and the intrinsically deviant nature of the novelties seem to open up certain spaces in the 'real world' that suggest dynamic and innovative activity within the emergent niche.

Kemp et al. (1998) suggest that a niche can be distinguished by the presence of three internal processes: a) the articulation of learning processes; b) the establishment of social networks; c) the development and alignment of strategies and expectations. Wiskerke (2003) states that these processes not only guide the innovation niche, but can also be used as indicators for evaluating its success.

The families' trajectories show that they rejected the 'expert systems', associated with the industrial production of poultry or tobacco, and chose to make medicinal plants their main farm product. This involved introducing complex productive processes that embraced changes in technical patterns, family organisation and social and market relations. It required the families to acquire and develop new abilities and practices, which they achieved through persistent observation and experimentation. Despite their pre-existing base of techniques, information, and patterns and practices acquired through their previous agricultural experience, an articulated learning process occurred. This process involved optimising and re-orienting the use of their resources, developing and fine tuning their processes in line with the available factors of production and creating (and re-creating) their abilities and knowledge. These activities were necessary to overcome the limitations imposed by the regime. Such processes are a key characteristic of the emergence of novelties (Oostindie and Broekhuizen, 2008), in addition to their potential to promote the innovation niche.

The second distinguishing feature of the niche was observed in the establishment of networks that developed between individual and collective actors. These provided the conditions for the emergence of social networks through which,

knowledge could flow and allow the articulation of learning processes to overcoming the limitations imposed by the economic order, the legal system, objective technical obstacles and political barriers to the claims and aspirations of the farmers. The creative and well-timed agency of the farmers and other actors led to the creation of networks that improved the farmers' organisational and strategic capacities to overcome obstacles, and influence ideas or events that eventually lead to 'novelties'.

The dynamic nature of relations within these networks and even with less complex individual engagements on a smaller scale seems to constitute one of innovating niches' strengths. Callon (2004) states that it is difficult to predict the results of a network because they depend on malleable and mouldable configurations built by actors. This unpredictability might stimulate novelties, which usually arise as irregularities. Networks often lack a well-defined objective but emerge out of the articulation of knowledge and experiences stemming from such relations.

Nevertheless, social order is never completely consistent; actors always find alternative ways of formulating their objectives, establishing specific ways of intentionally and consciously taking action and providing reasons for their behaviour, which is also driven by feelings, emotions, perceptions and identities (Long, 2001). In other words, the existence of a social network will not necessarily guarantee the success of the niche; it is necessary to 'learn' about the networks themselves, especially if we consider that the more diffuse the interests, the more difficult it is to obtain the specific engagement of actors promoting the niche.

"Novelties are related to expectations. It is, however, far from evident whether the eventual outcomes will match the initial expectations" (Ploeg et al, 2004:2). When actors are involved in a niche, they base their strategies and expectations on their own vision of a new socio-technical configuration. It is sometimes difficult to align the expectations of different actors if such visions are not clearly set out. In the case of ecologically produced medicinal plants, this study suggests that since there is no full agreement about 'expectations' we can consider it a 'quasi-niche'.

The field interviews illustrated these difficulties. At the local level, the farmers felt that the technicians and extensionists initially lacked faith in the emerging activity: they were completely sceptical about the viability of ecological production and even more so about medicinal plants. Many of the farmers' narratives stressed this point and the absence of support or specific knowledge. In the words of one farmer:

"It's very easy to achieve the conventional; it's much easier, if you produce with a conventional package based on pesticides and so on. [...] if you have a poultry production for example you will get a lot of technical support. Whereas for ecological farmers and even more so for those who produce medicinal plants, we are few, we are alone".

The networks in which the medicinal plant producers are embedded are mainly characterised by arrangements between farmers' organisations or unions, social movements and consumers' cooperatives. While some researchers and extensionists may be involved in the network, it is quite clear that their engagement is not always effective. Most of the cases show that the relationship between technical-scientific actors and the farmers still depends strongly on bilateral relations or even just on sporadic individual dispositions. One of the farmers described his relationship with a local university:

"They don't understand what I'm doing; they think that my system is anti-economic, they think that I need standards and a bigger scale to earn more, but this is not my objective".

The third distinguishing feature of the niche, the construction of alignments between actors, is possibly the main hurdle towards developing the niche for ecologically produced medicinal plants. However, due to some entrepreneurial success, the enlarging of networks and the intensification of public policies to encourage production systems based on agro-ecological principles and territorial sustainability, the situation is improving. Some technical/state actors are now more inclined to work with farmers searching for new socio-technical configurations. A farmer who has been producing medicinal plants for the last ten years illustrates this point:

"When I began, at that time, if you asked the extensionist something about organic or ecological production or something about fennel or another herb... they'd look down their nose at you. They had no knowledge about it, because they were trained within the framework of the green revolution. Today this has changed, [...] over the last two or three years they have started changing their ideas".

New policies in Brazil are recognising family farmers as important actors for promoting rural development, and the value of biodiversity as a resource for the healthcare system is gaining recognition and legitimacy. However it is probably too early to draw any definite conclusions about regime change. And we lack sufficient empirical evidence to assert this. Still, it is possible that windows of opportunities are being opened by changes at the landscape level, possibly in response to societal pressure in favour of sustainability. On the other hand, without overcoming the difficulties faced in the shared construction of strategies by actors at the micro level, it will be difficult to achieve complete innovation niches.

5. CHANGING IDENTITIES, ESTABLISHED COMMITMENTS

We should not neglect or forget the fact that "the technological niche is formed against the background of the existing regime and landscape" (Geels, 2001:8).

Thus, gaining allies to support a niche is not a simple process, especially because the values, practices and behaviours of some actors may reflect the prevalent socio-technical regime and impose barriers on new ways of thinking or acting. The actors involved in medicinal plant production are linked to different fields (including emancipatory movements, the technical-scientific domain, healthcare programmes and farmer, consumer and environmentalist organisations). This notwithstanding, they are all pervaded by the grammar of the dominant regime, which is largely impermeable to 'deviant' actions and maintains (some) rigid institutional conformity. Creating niches and/or transforming the regime is contingent on actors being willing to leave the mainstream and take on the possible risks or disadvantages of one or several new technologies (Elzen et al, 2004). In the case of ecologically produced medicinal plants this willingness must arise from both the actors who will generate the innovations and those who will use them.

The farmers producing medicinal plants generate novelties (some of them represented in Figure 1) by articulating learning processes and mobilising social networks, which include actors from different domains. However, it is important to emphasise that such networks do not, in and of themselves, distinguish or strengthen the innovation niche, mainly because the actors are not mobilised around common goals. In order to spur a complete niche formation it is necessary to construct shared governance that can guide the flows within and between the networks towards a specific aim. If this does not occur, a large part of the learning and opportunities will be lost or insufficiently developed.

The understanding of scientists and technicians, rooted in the technical-scientific domain, differs widely from the farmers' attempts to re-orientate their production systems and the technological developments required for producing medicinal plants. The farmers are willing to learn new things and even to abandon their old practices; they seem to always be ready to open communication channels with other actors and to adapt their own identities by becoming involved in different fields. They remain involved in agricultural work, the main symbol of a farmer, but at same time they are re-inventing or transforming their identities by acting, for instance, as researchers. The following comments by two farmers from Rio Grande do Sul illustrate this point.

I've done a lot of research, about each plant, beginning with the plant's name. I learnt that there are lots of them. [...] I read one book then another and just kept reading and reading. Once I went to the library of the Pharmacy Faculty. [...] There is plenty of material about medicinal plants, herbal medication and I spent many days there. Just researching; like a bookworm.

And really, I learn a lot, so many interesting things. [...] I've attended courses and lectures, [...] if one wants to deal with medicinal plants one also has to become a little smarter, more educated.

The development of an unusual farm activity that is distinct from most common agricultural production (grains, fibres, tobacco and food in general) changes the

demand for knowledge. As the farmers in our study are strategically positioned at the interface between agriculture and health, they articulate at least two broad fields of knowledge: they naturally manage codes, terminologies, and detailed information about phytochemistry, botanics, marketing and so on. These farmers' narratives commonly show how their 'mobility' across different fields has led them to acquire knowledge, which in turn has fostered the emergence of new identities. As one of them said: "*we are researchers too, we cannot stand still*".

By contrast, the majority of the actors in the technical-scientific domain seemed less able to formulate new goals or change the rationales that guided their actions: their commitment to the prevalent socio-technical regime seems to be stronger. An analysis of interviews, lectures and published papers reveals that techno-scientific actors still retain a focus on the homogenising protocols of production, narrowing the plant genetic base, developing conventional technological packs, increasing scale and meeting strict quality patterns determined by industry. This approach is at odds with the position adopted by the farmers, whose work and search for solutions are guided by the goals of enhancing agro-biodiversity and autonomy, reducing external inputs and constructing alternative markets.

This point is clarified by fragments of the talks, which scientists involved in research on medicinal plants delivered at the *III Simposio Latinoamericano en Producción de Plantas Aromáticas, Medicinales y Condimentarias* (Latin American Symposium on the Production of Medicinal, Aromatic and Condimentary Plants) at San Fernando del Valle de Catamarca (Argentina), between 19th and 22nd September 2006.

It's our goal to achieve better genetic material, finding the best plant design, finding the optimum growing conditions, climate, soil, light, finding ways to protect plants from pests and diseases, finding ways to eliminate weeds. [...] There is also the possibility of mechanisation and determining the best harvest system. [...] We want to identify and isolate the active principles, [...] We select the best genetic material to determine the optimal agronomic conditions for optimum yields and high quality standards; we genetically improve the species to develop high yielding varieties with a determined chemical composition (H. V., Universidad de Talca-Chile).

'Good Practices' are the way to provide a quality guarantee to the final consumer. And this is the responsibility of the producer. [...] It's necessary to set out a standardised operational procedure so that anyone can repeat the process. [...] The use of organic fertilisers is problematic, because the risk of contamination is high. The most important thing is to establish safety standards for the use of agrochemicals. [...] The ideal situation is to establish curves of absorption of nutrients for each species, so you can adjust the quantity of fertiliser for each crop (A.C., Universidad de Luján-Argentina).

During the same symposium, another Argentinean researcher, O. A. from *Universidad de Luján*, defended the global market's requirements for certain quality standards and a minimum scale of production: "*Small scale production presents problems in achieving the correct quality and acceptable standards for the international market*". The researcher also stressed that the lack of homogeneous genetic material and authorisation of specific herbicides for use in cultivating medicinal plants are significant technical barriers to progress.

One can see how such proposals or views are remarkably strongly related to the socio-technical regime of conventional agriculture. The talks make it clear that technological development should be driven by the classical modernisation principles already applied to food production. The statements make the goals explicit: to homogenise the production process and develop technological packages in conjunction with conventional top-down strategies that push for specialisation and scale enlargement.

Similar findings emerged from the analysis of papers presented during the III WOCMAP⁶ - Congress on Medicinal and Aromatic Plants, at Chiang Mai, Thailand, in 2003 and the final recommendations from IV WOCMAP⁷ held in Cape Town, South Africa, in 2008. Scientific research seems to be led by concerns about standardisation and technical efficiency, to be established through expert systems. This was evident in the calls to accumulate specialised knowledge about a few plant species, to develop protocols for biotechnological products and to expand knowledge about plant genomics. In the same line of thought, Bajaj and Ishimaru (1999) argue that it is necessary to engender transgenic medicinal plants to avoid biodiversity loss and to control natural variability.

Researchers often justify the push for complete control over biological diversity as a means of pursuing sustainability goals, set out in various international agreements (*e.g.* the International Convention on Biodiversity). This type of argument, aligned with economic interests, sometimes justifies the bio-prospecting of species and bioactive ingredients –which can potentially be patented, reserving private rights over benefits (Killbride, 1998). This situation is exacerbated by the well-known lack of recognition of local knowledge and any notion of fair payment for it (Santilli, 2005).

Another issue to underline is that the technological practices related to medicinal plants have a strong focus on establishing technical models that can guarantee consumer safety. However, these quality criteria are normally restricted to a hygiene standard (expressed in terms of the absence of microbiological agents), as documented and suggested, for example, in the GACP (Guideline on Good Agricultural and Collection Practice for Starting Materials of Herbal Origin) (EMEA, 2006). The guidelines are vague about controlling residues from pesticides, herbicides or growth promoters, with no explicit restrictions or

⁶ III WOCMAP - Congress on Medicinal and Aromatic Plants. *Acta Horticulturae*, Leuven, n. 676, v.1-6, 2005.

⁷ WOCMAP IV - Congress on Medicinal and Aromatic Plants. *Recommendations*, 2009. Obtained: 2nd June, 2009 (<http://www.icmap.org/about/wocmap4.htm>).

prohibition of their use. In Brazil, the discussions related to quality parameters have emphasised the need to produce medicinal plants without using pesticides, although there is no system of analysis or established protocols for compulsory control. In the guidelines of “Good Agricultural Practices (GAP) of Medicinal, Aromatic and Condimentary Plants”, there is limited encouragement for organic production and vague advice cautioning against the use of agrochemicals (Brasil, 2006a).

These specific examples illustrate the strong influence that landscape and the prevalent socio-technical regime exert over the rules, practices and actions related to medicinal plant production. But, of course, there are significant internal disparities within the technical-scientific domain and these generate conflict and tension in scientific discourses. There are divergences of position, ambiguities in proposals, and intrinsic contradictions within the main institutions. Often these tensions reflect individual actors’ degree of commitment to the dominant regime. These internal misalignments in the regime or landscape create opportunities and some *momentum* for the innovations emerging from niches (Geels and Schot, 2007). The full emergence of an innovation niche for the ecological production of medicinal plants seems contingent on the creation and/or identification of such opportunities, but this, in turn, depends on new social commitments between all actors involved in order to achieve some internal cohesion.

6. SOME CONSIDERATIONS ABOUT THE GAPS BETWEEN NICHE AND REGIME

The generation of a wide range of novelties associated with the niche emergence of ecologically produced medicinal plants diverges from the conventional agriculture regime, not only in terms of the innovative characteristics of techniques, products or markets, but, above all, because of the coalitions that form between the actors involved (including some linked to the technical-scientific domain). These coalitions, although sometimes partial and vague, create possibilities for networking and for learning and materials to circulate, which opens up some passages through the ‘hardness’ of the socio-technical landscape. However, the dominant socio-technical regime still seems to be driven by the generation of incremental knowledge.

Geels and Schot (2007) emphasised that actors who have strong ties with a specific regime normally implement only incremental changes. A technological regime contains both cognitive and normative structures that are integrated within a set of functional relationships that exist between the technological components and the actors along the production chain (Moors et al, 2004). Thus, it is important to find effective ways to overcome the idea that the regime in itself guides the recognition and the resolution of any problem created by within it.

The rules established through the regime, represented by a set of commands or requirements (Kemp et al, 1998), limit the actors' role to maintaining the practices unchanged, reproducing the rules by themselves. Smith and Stirling (2005) argue that these 'small decisions' are frequently invisible, but that they are responsible for reproducing the regime. However, changing the patterns of investing in infrastructure, of creating different markets, of transforming the health standards system, of providing innovation for experimental procedures and of democratising knowledge, will all depend on a myriad of small routine decisions that are not consistent with the prevailing rules of the regime. We are considering that, theoretically, these ideas are supported by the notion that actors and structures are jointly and mutually created and sustained (Bijker and Law, 1992:293). They also mobilise the view that the structuring element is contained in the practices themselves (Ploeg, 2003:15); and that agency is a 'root-metaphor', condensing fundamental processes of engagement between people and life experiences (Long, 2007:79).

The evolution of socio-technical transitions into structural disruptions presupposes material, symbolic, institutional and cognitive flows between different levels (*e.g.* niche, regime and landscape). It also requires being able to successfully manage these flows. Structure does not fix actors into immutable positions; yet the control of flows between levels is proportional to the degree of articulation that the actors can achieve through their projects. The whole process seems to demand an adjustment in actors' social commitments, an enlargement of negotiation spaces and the inclusion of multiple actors.

Changes in social, technical, organisational and institutional behaviour introduced into agriculture by novelty production are part of an ongoing transition in rural development, which challenges the 'developmental' path, characterised by a unidirectional concept of progress. Producing medicinal plants ecologically may not be a revolutionary invention but the novelty lies in the fact that it requires a reconfiguring of values and identities, as well as reconsideration of commitments between those who are involved.

The construction of new identities involves multiple learning processes that can disrupt pre-existing commitments, roles and rules. In this sense the farmers seem to be more able and willing to change than actors in the scientific-technical domain. Their new identities emerge from the growing internal coherence and strengthened social networks that have been established in order to find institutional protection for innovative spaces. The emergence of these new configurations is linked to the local context as much as to contextual knowledge and is dependent upon dialogue between different bodies of knowledge. Encounters between actors from the technical-scientific field and farmers can help promote socio-technical transitions towards more sustainable agriculture. As Smith and Stirling (2008) remind us, the promotion of a promising niche involves processes of cooperation, collaboration and consensus. However, the governance of this process is still unclear and the different actors still have quite different expectations regarding the outcome of such encounters. Furthermore,

the incumbent regime is highly structured and there are forms of power in place that favour certain actors at the expense of others.

As Roep and Wiskerke (2004) state, we are still in an early phase of transition in agriculture. Although there are signs of the emergence of a new regime and we can begin to delineate the contours of system innovation in different niches (as in this case study), a major regime change is still a long way off. Nevertheless, it is important not to disregard the fact that regimes often provide the materiality to field of practices, and that their institutions structure the repertoire of possible practices (Smith et al, 2010).

Apart from issues strictly related to the replacement of existing practices and inputs, sustainable rural development requires a socio-technical transition in agriculture. This involves ways of constructing knowledge that are capable of promoting structural changes and transforming the 'landscape'. This transition, which is fundamentally an evolutionary learning process, is related to the practices that actors construct at the niche level. The main challenges (even the analytical ones) lie at the interface between these two levels. The difficulties in establishing connections between an innovation niche and the socio-technical regime represent not only a barrier to transition, but also an obscure and uncharted theoretical area.

7. CONCLUSIONS

Our analysis of the emergence of the innovation niche associated with the ecological production of medicinal plants leads us to conclude that the integration of methodological and analytical elements from MLP and AOA provides a promising construct for multi-level, multi-aspect and multi-actor approaches. This 'dialogue' may perhaps create a new agenda for debate and research on transition management in agricultural technology.

The novelties associated with the ecological production of medicinal plants have been produced essentially in opposition to the conventional agricultural regime. They can be seen as evidence of the never-ending learning processes surrounding the networking between different actors. This suggests that, by introducing social, technical, organisational, institutional and behavioural changes, novelty production in agriculture has sound potential as a vehicle for promoting the transition towards sustainable rural development.

This is however not an unqualified success story. The emergence of an innovative niche for medicinal plant production is far from complete. Our analysis suggests that it is difficult to align actors' expectations and goals, especially in the presence of strong commitment to the prevailing regime. One reason for this could be the lack of a legitimating interface with the technical-scientific field.

Our field-work shows that the farmers producing medicinal plants ecologically seem to be willing to break their commitment to the incumbent regime, largely

by constructing new identities through multiple processes of learning and experimenting. The increase in material, symbolic, institutional and cognitive flows between niche and regime is necessary to achieve transitions, but the process seems to demand a greater adjustment of social commitments, an enlargement of negotiation spaces, and a governance system that includes a wide range of actors.

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Chapter 2. The contribution of conversion to organic food and farming to the analysis of dynamics and governance in transitions towards sustainable agri-food systems

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Abstract

Sustainable agri-food system approaches are rooted both in the environmental movements and in the political-economic critique of the contemporary system. Organic food and farming (OF&F) as an alternative agri-food system among others encompasses multiple dimensions and performances, enabling the study of conversion as a prototype of transition. We use the multi-level pathways framework to describe the transition process. We first present OF&F as a heterogeneous entity and examine the consequences of acknowledging its diversity. We show that OF&F as an innovation influences the mainstream design of agri-food systems, and we explore the strategies of the actors in charge of its development. We then introduce how different levers can influence types and levels of conversion, with actors who have diverse expectations to articulate. This raises the issue of time frames with short-term adaptations and long-term transitions. Finally, we introduce the market itself as a composition of sectors and territories. We argue that this diversity has to be kept beyond consensus to build multiple strategies. We represent the initiatives of different networks in their spatial and social dimensions. This begs the question of the coexistence of these models. We conclude that the policy level has a prominent role to play in enabling this coexistence.

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1. INTRODUCTION

At the beginning of the 21st century, agriculture has reappeared as the key for the world's major balances (Mazoyer, 2004). It has been pointed out that common representations in terms of a hierarchy between economy, society and nature need to switch to a new paradigm (Passet, 1996). Establishing links between the fields of agriculture, ecology, economics, and the social sciences may be seen as the burgeoning of a new regime, which could be a response to sustainable development challenges (Possas and Salles, 1996).

Several authors argue that conventional agriculture is not sustainable and that radical changes are needed (e.g. Pretty, 1995). Although the extent of the necessary changes may be questioned, there is general consensus about society's desire to internalise some of the externalities of agriculture (Buttel, 2003). Princen (2002) argues that agriculture is a “modern frontier economy” with two main problems: *shading* (the obscuring of costs) and *distancing* (the spatial separation of production and consumption). To picture the re-design of the agri-food system, Organic Food and Farming (OF&F) is considered as a prototypical answer:

- as an ecologically-based agriculture, it tends to internalise societal costs of production;
- its bottom-up governance initiatives confront the forms of governance vested in the dominant regime (Smith et al., 2008).

We use the conceptual theory of “transition pathways” to present OF as an innovation in the mainstream agriculture and a prototype of sustainable agri-food systems. The case of conversion to OF&F is considered as a development process and is to study the ways stakeholders influence the global paradigm, in interaction with the conventional actors, and the tools used to stimulate these transitions: advice, market, and public policy.

Following national or EU development plans, the rapid growth of OF&F expected by public authorities and civil society pleads for upscaling OF&F and for a variety of stakeholders. The ambition to develop OF&F suggests new farmers and new actors who come from various institutions, have diverse relations with nature and markets, and generate diverse patterns to “enter” in OF&F. OF&F development is increasingly collective and multi-dimensional, since both farmers' trajectories and society's expectations are manifold. Indeed, it appears that different actors take part in the dual societal role of OF, where it “*on the one hand provides for a specific market responding to a consumer demand for organic products, and on the other hand delivers public goods contributing to the protection of the environment and animal welfare, as well as to rural development*” (CE 834/2007). One pending question is whether this multiplication of stakeholders can sustain or counteract OF development. At least it can be assumed that competing development models are at stake.

In the first section we show that OF&F is a heterogeneous entity, which entails consequences both for its development and in terms of research. We then consider how the diverse expectations and capabilities of actors can be articulated during conversion processes. Finally, we introduce the market as a composition between sectorial and territorial logics. This enables us to represent the initiatives of different networks in their spatial and social dimensions, and raises the question of coexistence of these multiple models. By matching dynamics and governance, we are able to examine the different ways of combining growth, development and integrity of OF&F.

2 CONVERSION TO OF&F AS A FIGURE OF A TRANSITION PROCESS

2.1. A shift in paradigms

Many authors suggest that OF&F may provide solutions to the current problems in conventional agriculture (Lotter, 2003, Bengtsson et al., 2005), and OF&F has often been suggested to be a new paradigm in agriculture (Beus and Dunlap, 1992). New paradigms in research areas arise when there are problems and issues associated with the current state that cannot be solved. We use the term “paradigm”, introduced by Kuhn (1970), while drawing on the work of Foucault (1966) regarding the “*episteme*”, the whole scientific and cultural project and value system of a society in a given period. Busch (1994) suggested that public agricultural research is at an impasse partly because of the continued hegemony of the key goal to increase productivity (Chrispeels and Mandioli, 2003). Historically, the evolving paradigms of agronomy can be identified as successively chemical, physical, biological and, more recently, ecological (Robin and Aeschlimann, 2007). Ecological engineering suggests that the relationship between short-term productivity and sustainability will inevitably be negative, and considers production strategies in terms of “trade-offs” (Weiner, 2003).

OF&F, which represents certain values – ecology, equity, health and care (IFOAM, 2005) – can be considered as a model of value-laden agriculture, going beyond classical agro-economic performance and managing the tension between profits and values. Conversion to OF&F is an exemplary and well-informed case that we can use for broader reflection on changes in agricultural and agri-food systems. It can be seen as a general figure of the transition of agriculture (Sangar and Abrol, 2004), which can refer to the notion of sustainability (Elzen & Wieczorek, 2005). But OF&F is also sometimes considered as not being productive enough, and the supposed systematically lower yields following conversion are pointed to as an obstacle for farmers adopting OF&F. However, yield increases would create a conflict of objectives in OF&F, shifting it from an ecologically-based farming to an intensification process relying on external inputs. This process is also called “conventionalisation” of OF&F (Darnhofer *et al.*, 2009). On the other hand, in conventional farming, attempts to maintain yields close to their current high levels while improving sustainability are manifold. Such low-input or ecological

strategies can be related to “organification”, as a counterpart of “conventionalisation” (Rosin & Campbell, 2009). We assume that beyond formal oppositions or potential bifurcations among production patterns, these two approaches can converge by the incorporation of the idea of long-term sustainability into overall agro-ecosystem design and management.

2.2. Network of actors use conceptual frames to disseminate innovation in a “transition process”

The *network* concept can be applied in two ways: first, as a heuristic device to describe linkages and interactions among actors; and second, as a variable that depends on different factors, such as the institutional environment and the ideas and strategies of the organisations of actors involved (Moschitz & Stolze, 2009). In this chapter actors are taken not as individuals but as collective entities, i.e. private or public. A public actor may be the facilitating agent, but transition initiatives may also be initiated within business communities or civil society (Kemp and Rotmans, 2005).

Social movements struggle to define the meaning of specific practices and policies. They use a *frame*, composed of ideas and practices that are strategically articulated through language to identify a problem, propose a solution, and motivate others to act (Bateson, 1972; Goffman, 1974; Snow et al., 1986). According to Benford and Snow (2000), frame transformation is defined as the process of adding new meanings to already existent social movement frames. Framing is an interactive process of social construction and one of the most symbolic strategies. The theoretical frame helps the efforts of social movements in institutionalising changes. The frames, or “rule-based models of action”, are multi-dimensional (Giddens, 1984). The demonstration of viable alternatives may change perceptions and lead to innovation and transition.

The *transition process* has been described as a multi-level pathway: the level of “niche innovations”, where radical novelties emerge, the socio-technical regime as the dominant design, and the socio-technical landscape as the macro-level (Geels & Schot 2007). Literature on niche development emphasises three main processes: learning, network building, and articulation of expectations (Kemp et al., 1998). The fourth process comes from research diffusion : the diffusion curve may take off beyond a certain threshold (e.g. between 5 and 20% of cumulative adoption, according to Rogers (1996)) when the frame has achieved such legitimacy and resonance that diffusion can happen faster and wider. Further frame transformation poses a challenge to the movement’s identity, goals, and strategies. More powerful interests can manipulate meaning or transform a frame for its own purpose (Frye, 2009).

Geels and Shot (2007) also proposed a typology of four transition pathways: “*transformation, technological substitution, de-alignment and re-alignment, reconfiguration*”, depending on the stage of development of the niche innovations to interact on the dominant regime. In the same way, several approaches have

been used to take into account the transitions in agriculture, and the possible conversion steps from conventional farming to the design of sustainable agro-ecosystems. This typology can be compared to another model proposed by Hill (1985), which analyzes transition pathways, with three levels “*Efficiency-Substitution-Redesign*” (ESR) that can be applied both to farms and to large organisations. The Efficiency level is close to “transformation” in so far as the changes are within the conventional system and based on incremental improvements (e.g. reducing the consumption of scarce resources). The Substitution, -similar to “technological substitution” – level corresponds to a replacement of technology (the products and procedures are more environmentally benign). The Redesign approach demands greater and deeper changes in the way it necessitates the taking into account of a more global perspective (and the need for a construction of interactions between agriculture and ecosystem components). It can be correlated to the “reconfiguration”, which generates real adjustments in the basic architecture of the regime. A fourth level can be added to E-S-R (Gliessman, 2007) to reconsider the link that can be built between food production and local consumption.

Finally, the level of “redesign” can potentially bring permanent solutions to problems, in the way it acts proactively, but there can be different timing, because changes are gradual and integrated processes are adaptive in the short term and evolutionary in the long term (Norghaard, 1984). The observed progression of conversion is often the efficiency-substitution-redesign pathway (Hill & Mac Rae, 1995). Paradoxically, the initiatives of redesign often generate much larger efficiency gains than innovations aiming only at the efficiency of the system do (Fletcher & Olwyler, 1997).

2.3. Analyzing OF&F diversity, development models and dynamics

OF&F as a heterogeneous entity

A historical approach can help to identify the founding paradigms and their differences, mainly between Steiner’s organic vision of a farm integrating animal raising as a key component of the farming system, and Howard’s vision favouring soil fertility and humus management (Lamine & Bellon, 2009a). This belies the idea of a unique original paradigm for organic farming and contributes to the necessary acknowledgement of organic farming's internal diversity (Besson, 2007).

Most publications or public policies implicitly consider OF&F as a relatively homogeneous entity. For example, OF&F performances, technical bottlenecks, and consumption or supply chain issues are often studied and discussed as a whole. But OF presents multiple combinations of performance criteria, exhibiting successful “trade-offs”, beyond the classic distinction between “economic versus environmental performances”, “ethical versus opportunistic”, “small versus big farms”, “redesign versus incremental changes”, “local versus globalised food

chain". Some studies emphasise organic diversity. For instance the differentiation among farming situations can be identified through production systems and marketing channels (Desclaux et al., 2009), or related to three main approaches: no chemicals, agro-ecological, and integrity approach, close to the holistic biodynamic principles (Verhoog et al., 2003).

Many variables could be relevant to account for this diversity. However two comprehensive axes can be identified (Sylvander et al., 2006). The first axis opposes basic compliance with OF standards to system redesign. It is consistent with the ESR model introduced previously (Hill, 1985). The second axis refers to governance patterns, whether individual or collective (Sylvander & Kristenssen, 2004). The proposed framework can also help meet the needs of this diversity of farmers, to facilitate their transition towards a global management of their agro-ecosystem. It also requires different forms of knowledge from producers, advisers and certifying agents (Seppanen & Helenius, 2005; Sautereau 2009). Although the ESR model makes it possible to differentiate farming situations, it should not be considered as a unique and linear pathway for farming systems development. In OF&F, inputs substitution is a basic requirement, since alternative production methods are advocated. It is also possible to search for a higher efficiency of inputs in OF, without redesigning the system. For instance, the prevalence of inputs substitution and efficiency does not challenge monoculture or the dependency on external inputs, and limits the potential solutions to the socio-economic and ecological crisis of modern agriculture (Bellon et al., 2010).

Is the growth of OF&F uprooting it from its historical "niche"?

While there are overall decreases in farmed acreage and the number of farms, the opposite is true in organic agriculture (Klonsky & Tourte, 1998; Agence Bio, ONAB, 2009). Apart from natural food stores, organic food is increasingly available in supermarkets, convenience stores, and restaurants. This growth in the market share, by virtue of the sheer number of people involved, is bound to lead to growth in the organics movements as the number of people who understand organic agriculture and care about it also grows. As more actors become interested in organic farming, interactions among actors also increase (Lynggaard, 2006). Moreover, general agricultural policy networks are opening up to organic farming policy actors.

Smith (2006) has demonstrated the dynamics of niche innovation for OF&F, which was initially pioneered by dedicated green activists in secluded niches and whose lessons and practices were translated and picked up by conventional actors (especially supermarkets). Niche actors thus acted as front-runners, whose practices gradually changed regime rules. Dedicated translation activities are important in such niche–regime interactions.

3. STIMULATING CONVERSION: DYNAMICS WITHIN TRANSITIONS

3.1. Various components in a seamless web

The indicators for the stabilisation of viable niche-innovations that are ready to break through widely are the following:

- learning processes have been stabilised in the dominant design,
- powerful actors have joined the support network,
- price/performance have improved and there are strong expectations of further improvement (e.g. learning curves) and
- the innovation is used in market niches, which cumulatively amount to more than a 5% market share (Geels & Shot, 2007).

We place the productive activity of farmers in its social, economic and political context, which strongly influence the capacities of farmers' evolutions. The factors determining the adoption of OF&F by farmers are widely diverse, and these farmers' motivations have been studied extensively (Lamine and Bellon, 2009 a). Economic studies have shown that three external key factors are also really decisive incentives to convert to OF: clear signals of public policies (financial support in particular), positive signals from the market (increasing demand for organic products, better prices paid to the producers), and easier access to information and advice (Padel et al, 1999). A comparison of European cases indicates that the joint implementation of incentive policies and advice seems to allow for a greater increase in conversions than does the effect of each of these actions individually (Kauffman, 2009). Agricultural professionals (namely extension officers, scientists, researchers and academics) play a big role in encouraging the adoption of innovations (Van den Ban and Hawkins, 1988).

We assume that the extension of OF&F has been made, and will be made in a dual movement:

- a generalised global and diffuse up-scaling, with an increase of OF&F in extension programmes for the producers: advisory services, learning processes, subsidies, etc.
- a multiplication of "spots of excellence", in which regions and local authorities have a major incentive role and potential identity (eco-regions, etc.).

Consequently public policies and extension services have to influence these two forms of development, with adequate individual support (agri-environmental contracts, subsidies for the costs of certification, specialised advice, etc) and collective actions (e.g. for the conservation of water-resources). Different forms of support are proposed by several stakeholders to facilitate conversion: organisation of knowledge (constitution of references and networks), of learning sessions and of advice. The introduction and promotion of new practices

mobilises multiple strategies, because of the diversity of farmers' expectations and trajectories (including in the stewardship of attached biological processes). The way technical or economic problems are addressed and the possible solutions will vary accordingly, with specific needs for adapted references and support.

3.2. An intrinsic difficulty: managing a more holistic, complex and autonomous system

OF&F represents values which are difficult to codify. For instance, when an ecological principle recommends valuing abundant resources and saving scarce resources, how can this be translated into prescriptions for technical advice? How can the essence of the agronomic, ecological and social project of OF&F be conveyed? When the agricultural systems and the answers are over-specialised, how can the global concepts such as the founding principles of OF be implemented, and what propositions for improving extension services can be made?

Conversion to OF may appear difficult because of transitional costs and lack of knowledge of new production methods, which require more autonomy (OF calls for observation, anticipation and adaptation). It may also appear difficult because of a more systematic approach to the time lag due to the slower response of an ecosystem managed in an ecological way (for instance soil fertility). Kilcher and Zundel (2007) show that it takes years after a conversion to get back to the yield which was observed with conventional practices, and the more intensive the previous system was, the more time it could take. Conversion is a global transition pathway; it can take far longer than the administrative time of two or three years (Lamine & Bellon, 2009b) which claims to take into account the temporality of the changes. It often raises both levels of complexity (internal and external) with reference to system modelling (Le Moigne, 2000), because both the production methods and the farm environment are re-defined.

One of the main difficulties for specialised technical advisers is to envisage the system in its coherence, when their advice is given at plots or species levels, with a specific problem-solving approach. It is moreover not easy to persuade farmers to accept additional risks, which can be more or less significant depending on their production and site-specific conditions. These risks are connected to a more autonomous management with a lower use of inputs. It is often easier to recommend a phytosanitary treatment, which anyway does not cost much in comparison with the risk of losing part of the production. Some advisers claim that they were forced to envisage alternatives, even upstream of the problem, due to the banning of a treatment for instance. The use of regulations in this case can favour proactive initiatives (Sautereau, 2009).

The reorganisation of advisory schemes is another relevant factor. Because it is increasingly privatised (Rémy et al. 2006), advisers who have to keep their clientele will make farmers take fewer risks and will encourage them less to

reduce inputs. Sectors are also more and more "integrated", with heavy involvement of the supply cooperatives, whose turnover depends on the sale of inputs.

Support for producers to adopt more complex systems aiming at input autonomy implies that the acquisition of diversified and articulated skills is facilitated. Accompaniment of conversion is in itself a model of accompaniment of transitions towards systems presenting higher adaptability to change.

3.3. The OF&F networks and the “actors of the regime” in charge of extension

Spreading the reference frame of OF&F

The agricultural extension system integrates a dual function which can sometimes be contradictory: a function of "extending" established references, but also a contribution to the "innovation" and construction of "alternatives", which sometimes requires to question this diffusion model and the used references.

In France, OF&F has been developed by two networks:

- the “organic specialised” network with groups of organic farmers, included in regional federations within the FNAB (National Federation of organic farmers) with 250 advisers, as well as the ITAB (Technical Institute of Organic Agriculture) and its network of specialised Centres (CREAB, SEDARB, GIS Bio, etc.) for the coordination of experiments and the references acquisition in OF&F.
- The classical or “conventional” network, with “actors of the regime”: i) the departmental Chambers of Agriculture (CA), themselves with their regional and national level, with 160 advisers, and ii) the Agricultural Technical Institutes (ITA), federated by the ACTA (Association of Agricultural Technical Coordination), and all the experimental Stations. The Chambers, like the ITA, generally have one organic adviser, sometimes more, whose time dedicated to the development of the OF is variable.

The local importance and roles of each of the networks differ considerably, depending on the context, the history of the development of OF&F, and its perception by the “actors of the regime”. Today, the latter generally consider that OF&F should not be separate from agriculture as a whole, and suggest that all existing knowledge can provide technical answers to organic farmers as well (in particular issues on weed control, irrigation, characteristics of varieties, etc). The CA consider that it is part of their mission to accompany the development of OF&F. And within the context connected with the “Grenelle de l’Environnement” and the French national OF&F development plan (Agriculture Biologique “Horizon 2012”), which had the ambitious objective of tripling land used in OF&F by 2012, certain CA recently invested more in actions for OF&F, which were made compulsory within the PRDA (Regional Agricultural Development

Programme). Sometimes OF&F is also considered as one of the "modalities" to be taken into account by the technical institutes producing references, which are increasingly either forced or inclined to work on "alternative" techniques (green manure, biological control, etc). In this way, techniques of OF&F are "compared" to conventional ones.

But the specificity of OF&F is also questioned: the production system, an incentive to think globally – including on the food system in a broad sense –, should also be studied and assessed, and not necessarily in comparison with the performances of the general regime. Is it necessary to use the same indicators, assessment and decision-making methods as the conventional ones? Or is it necessary to agree to be "confused" a while by new reference values based on other criteria and optima? The performance criteria of conventional agriculture need to be questioned, because the system was built to maximise these criteria. If not, the transition cannot occur, or it will get no further than simple improvements in an unchanged reference frame. For instance, could autonomy, mutualistic relationships, conscious caring, the dedication of a part of the resources to reproduction *versus* production, and finally sense of place be part of the assessed values (Hill, 2003)?

The "lock -in" of the socio-technical regime

Technical change is always a complex process with both biophysical and socio-economic aspects. It results from changes in the thinking and activities of individuals, households and communities, as well as in market and organisational relationships. In such transitions, learning is applied to new systems of behaviour and valuation, not just techniques or methods. (Pretty & Uphoff, 2002)

The conventional actors tend to mobilise more "experts' statements" within the framework of "technological transfers", while OF actors of the associative type tend to implement more discussion groups to assess knowledge and adaptive management. It has often been said that in organic farming, the transfer of knowledge does not have to follow a "top-down" model from research towards the producers via the advisory services (technological transfer, or diffusionist model), but should develop as a system of knowledge including all the actors ("ecological and fair knowledge system"). This reflection spreads the concept of "system" to the elaboration of the knowledge, by integrating multi-disciplinarity, a systemic approach, a strong consideration of farmers' experiences, and the implementation of on-farm research. The necessary integration of the various types of knowledge, in particular local and traditional knowledge, in the processes of innovation seems to be gaining recognition today, beyond the circles of OF&F (IAASTD, 2009). A specific challenge for the knowledge system is the conversion from conventional to organic farming. Conversion to organic farming requires merging scientific knowledge with local knowledge, stimulating learning and triggering agricultural innovations in rural communities (Röling and Wagenmakers, 1998). The knowledge in OF&F is sometimes characterised as "between tradition and modernity" (Kummer et al., 2010). The important point is

the interference of niche-knowledge with knowledge from the actors of the regime: they often spread by the hybridisation of networks, as for instance in the RMT DévAB in France – a “mixed technology network” for OF&F development (Sautereau, 2010).

Farmers have to incorporate the idea of long-term sustainability not only into overall agro-ecosystem design and management, but also into all segments of the food systems, especially those stakeholders who are used to “product-focused thinking” (Gliessman, 2010). A survey on approximately 1200 US organic farmers found that the greatest restraint to organic farming conversion was uninformed extension officers (OFRF, 1999).

The reluctance, even resistance, of farmers and advisers to modify their practices and advice, in spite of available solutions, have led to the hypothesis that their appropriation implies a new conception of their relationship with nature. For example, in the case of tree crop production, beyond the uncertainties inherent in the efficiency of the alternative techniques of protection, an ecological management of the orchard deeply questions categories of thought around which the professional identity and excellence of orchard farmers has been built (Paratte, 2010). The same analysis can be made of the change of status of practices formerly implemented and then depreciated by the dominant technical culture. Not long ago considered as indicators of a lack of technicality of wine growers, and more or less abandoned, certain practices are being “rehabilitated” and reintroduced today, in line with current tastes (mechanical work of the ground in vineyards, for instance). This leads to a re-qualification of both farmers' and advisers' practices, which is not something to be taken for granted. It implies the need to overcome incompatibilities between cognitive systems, understood as wide sets of knowledge and standards, which stabilise a network of production (Stassart & Jamar, 2009). Farmers or advisers who initially opted for a technico-economic model that was hardly compatible with organic standards can with difficulty envisage a change because they are blocked by requirements pertaining to the whole production sector, and which echo their own knowledge and initial practices. It makes the transitions between conventional and organic systems particularly tricky. Only professionals who believe conventional agriculture is currently unsustainable will be likely to be looking for alternative forms of farming to take its place (Wheeler, 2007).

Darré (1996) underlined the importance of the imposed “conformity” on social and cultural standards generated by the group to which the farmer (or the adviser) belongs. For instance, narratives like “ecological intensification” are blossoming: the process of intensification, which has been largely developed, is applied to ecology and therefore would be more easily accepted than a global switch to OF&F. After having increased *the use* of inputs to control the agro-ecosystem, the perspective is to search for a better *use* of the functions of the environmental components in order to keep on increasing production (Griffon, 2006). Here the paradigm has not really been reconfigured, but the trend is to pursue maximisation by extending intensification to eco-systemic services, which until now tended to be neglected. This large audience is also linked to the

controversial question of OF&F productive performances in a context of the growing question of fulfilling the needs of 9 billion people in 2050 (Paillard et al., 2010).

4. THE ORGANIC AGRI-FOOD SYSTEM

4.1. Organic market: organic certified products, giving value to farmers' practices?

The political-economic critique of the food system analyzes the changes in this system over the past 50 years (Goodman & Redclift 1991, Winson 1993): the marginalisation of small-scale primary producers and processors; the loss of rural ways of life; horizontal and vertical integration, consolidation and monopolisation in the food industry; manipulation of food and its packaging to increase profits; alienation of food consumers, including “de-skilling,” or the loss of people’s abilities to grow and prepare food (Power, 1999). Furthermore, anonymous markets alienate or separate us from “true understanding of our relations with others, and with nature” (Pepper, 1996). Latacz-Lohmann and Foster (1997) have identified the contradiction between an ecological agriculture and mainstream commercialisation as a structural incompatibility. Is it then possible for organic agriculture and organic markets to create changes within the political-economic system in which they are embedded?

By shedding light on production methods encouraging us to look beneath the superficial appearance of commodities as mere depersonalised things, green businesses can reduce or eliminate the alienation between consumption and production that conceals natural-social relations in the production process and is at the root of the problems in our agri-food system (Elkington et al., 1990). Still, there are contradictions between organic ideals and practices, e.g. the reductionism of organic standards, the limitations of private organic certification, and the widespread practice of input-substitution. As the market matures, competitive pressures are already beginning to lead some producers away from strict adherence to the goal of ecological soundness. The market for organic products probably can enhance ecological soundness in agriculture, but in the long term it requires changes in political, social, and economic structures and relationships. The question then becomes: does the market for organic agriculture have the potential to instigate these larger changes, possibly fuelling a vital social movement?

This is what will be required. Organic labelling is simply not enough to create an agri-food system that provides real values. After all, as Marx (1977:437) pointed out long ago, “*Value does not stalk about with a label describing what it is*”. Fundamental change, therefore, is not likely to occur through the market alone. Despite these limitations there are nevertheless ways in which the organic market could contribute to a broader movement leading to collective action. The

organic market tends to strengthen civil society and is becoming a catalyst for real social change (Allen, 2000).

The values conveyed by the quality market (organic, slow food, local food, fair trade, etc.), which were considered as characteristics of the social-political protest movements are no longer “niche markets” next to the dominant ones. They have an increasing impact, as they influence and change the dynamics of the dominant agri-food system. The big companies themselves recognise that they have to integrate these values, and consequently create segmentation of the market (Wilkinson, 2008). The “universalisation” of these values engenders the question of the coexistence in the same territory of industrial farms and small farmers, with all intermediate structures in between. The risk of an exclusion of the pioneers exists. Some of the biggest changes in the food system probably need to come at the policy level (Gliessman, 2008). Another success has been to negotiate price rates for collective certification, in spite of the fact that the industrial agri-food system manages a private certification for export products.

The framework of efficiency/substitution/redesign can also be used to identify and to categorise strategies for modifying agribusiness practices. Diverse short, medium and long-term strategies can be implemented by governments, community groups, academics and agribusiness to support transition, for instance corporate greening, ethical investment, changing the legal status of the corporation, new business forms and the development of ecological economics (MacRae et al, 1993).

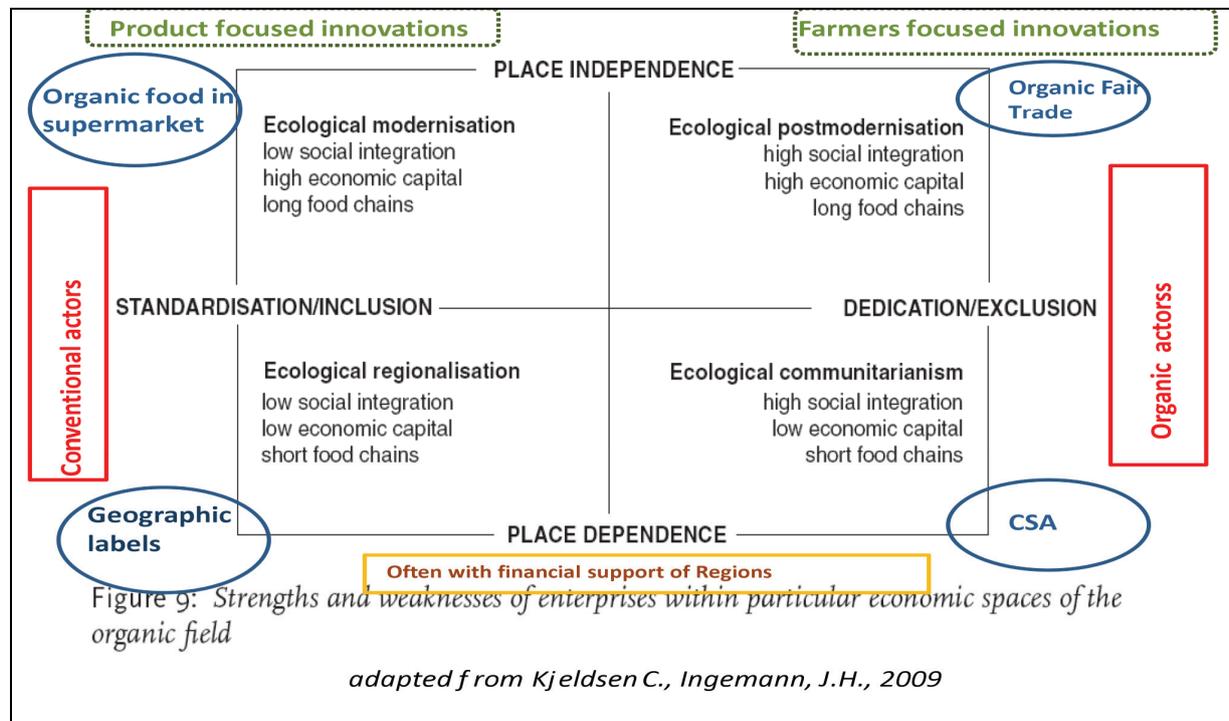
4.2. The issue of the coexistence of organic models

Private groups tend more and more to pay incentives to farmers to convert their farms, in order to meet the market demand. Government subsidies for conversion are related to the land area used, so that small farms often do not benefit from public subsidies. This can be considered as a failure of the policy with regard to the multi-functionality of agriculture. But civil society plays an increasing role, being concerned by fair, ecological and regional trade, for instance through CSA (Community Supported Agriculture). As Morris (1996) mentioned, “small is the scale of efficient, dynamic, democratic, and environmentally benign societies”. In Canada, the sustainable food system’s approach is often labelled “community development”. This approach is compatible with “communitarianism,” as described by Frazer and Lacey (1993). But these types of projects have only limited potential as alternatives on a larger scale, and cannot be considered more authentic just because of their degree of exclusivity (Kjeldsen & Ingemann, 2009).

The classification of Kjeldsen and Ingemann (2009) has been used to represent the panel of organic strategies and initiatives (Fig 1). The vertical axis refers to place dependence, and the horizontal one to social dependence. The standardised OF&F strategies tend to respond to the market demand for a “certified organic product”, with low social integration. In contrast, the dedicated OF&F strategies

are more focused on innovations based on farmers' initiatives. Post-modernist networks share the characteristic of social exclusivity with ecological communitarianism, but can operate on a much larger scale, thanks to the effective mechanisms they employ (for instance organic fair trade, or organic box schemes through e-web).

Figure 1: Coexistence of organic initiatives



Public order in favour of fast development of OF begs a fundamental question: does OF have the capacities to meet the fast-growing organic demand in compliance with the principles underpinning it? The depth and the speed of changes towards sustainability are not easily compatible. The risk is that OF may be summed up in a series of elements matching the guidelines, and of the fundamental principles being neglected, without necessarily being translated into statutory points (Seppanen & Helenius, 2004). Indeed, OF&F is questioned on its capacities to develop an alternative food system in view of the strengths of dilution and appropriation to which it is subjected: risk of "conventionalisation" (Darnhofer et al., 2009).

In order to take into account the strengths and weaknesses of the diverse strategies and to put them into the perspective of OF&F development, we cross (i) the actors' representation of OF&F and the way they envisage conversion (levels of changes in relation with the ESR model from Hill), with (ii) the potential growth of OF&F and its development (according to Kjeldsen & Ingemann), and (iii) the distance with the integrity of the OF&F and its values (cf. theory of "conventionalisation") – see Table 1 which illustrates the internal debates of OF&F regarding its own roads and future (Niggli et al., 2008).

Table 1: Link between conceptions of conversion, OF development process, and integrity

Conception & implementation of conversion and OF&F	OF&F potential growth	OF&F development in the spatial and in the social dimensions	Risks
<p>OF is considered as a simple agroenvironmental measure to contractualize, or as a segment of the market to be supplied. Conversion corresponds to some technical points "to be adapted". The changes are marginally, and can be purely incremental: Efficiency or Substitution in ESR model (Hill, 1985) Transformation, or Technological substitution in Geels & Schot (2007)</p>	<p>Rapid growth</p>	<p>Objectives are attained in terms of converted areas Everyday acceptance of OF (Standardisation : OF inclusion (Keljdsen & Ingemann, 2009) Logistics to supply long chains, public procurements (economy of scale and ecological modernisation)</p>	<p>Conventionalisation of OF&F: loss of "integrity" (Guthman, 2004) Darnhofer <i>et al.</i> 2009) Greenwashing of products</p>
<p>Strong vision of OF as revision of the system and corresponding to a real project of the farm, including innovative links with consumers. Conversion corresponds to radical changes, in a more holistic view: "Redesign Paradigm" in ESR model, (Hill, 1985) "Reconfiguration" in Geels & Schot (2007)</p>	<p>Slow growth</p>	<p>Organic land area is developed below public objectives OF Strong identity ("exclusion", Keljdsen & Ingemann, 2009) Recomposition of marketing towards shorter circuits (ecological communitarianism)</p>	<p>OF not developing fast enough, and potentially rivaled by imports</p>

An important issue is to consider the changes towards sustainability as continuous processes. Parts of alternative elements are incorporated in the regime, thus adding new meanings to the term "conventional", and making the global environment change. Unless exclusivity is a goal in itself for the actors involved, these actors will try to make it more inclusive or "conventional" (Kjeldsen & Ingemann, 2009). Once the new frame has been legitimated, the alternative networks tend to re-position themselves, considering the parts of the alternatives, which were not taken into account when included in the socio-technical regime. That is what is actually at stake in France with new dynamics in the organic networks, which study new organic standards in order to promote more coherent practices (as suggested by the name of this label: "Bio Coherence") than the ones allowed by the current European Regulations - CE 834/2007.

4.3. Multiple frames, strategies and involvement of stakeholders: beyond consensus

Our hypothesis is that the variety of ways followed by the currents and the movements is not in itself contradictory to global efficiency of an "ecologised farming", and to a transformation of the agri-food system: food security and sustainability encompass a diversity of approaches to a variety of problems. This is important to understand, because the way we frame a problem determines the ways we try to solve it (Tesh 1988), and when there are various players involved in the adoption process, different approaches are needed (Rieken & Boland, 2010).

Transitions are contested phases, and different groups struggle, negotiate, and form coalitions (Geels, 2005). Outsiders are important, because they translate socio-technical landscape pressures and draw attention to negative externalities, which regime insiders tend to neglect (Van de Poel, 2003). This is why some authors underline the necessity of a "creative conflict" between organic networks (which hold up ethical values) and those of conventional agriculture (which argue that sustainability cannot omit profitability), to maintain a strong identity of OF&F and innovations in OF&F, which would not allow in a generalised consensus (Schermer, 2007; Moschitz & Stolze, 2005; Michelsen, 2001).

It has been shown that possible conflicts could lead to a "mutual adaptation" (Moschitz *et al.*, 2005). Others assume that maintaining "creative conflicts" can be a strategy to keep OF from being captured by strong global market forces. Depending on the country, the relations between the organic and conventional networks are either "pure competition" or "pure cooperation", conversely compromising the possibility of constructive debate.

Furthermore, different actors may accelerate or widen the adoption of a frame or innovation by offering different reasons why various audiences should adopt it. For instance, the use of an economic approach, "the soil as capital", or the affective metaphor "mother earth" can reach different audiences (Frye, 2009).

In the same way, Alrøe and Noe (2010) suggest that intervention in complex problems should not strive for consensus on problems and goals. The heterogeneity of stakeholder perspectives and their relations can maintain a dynamic, multi-dimensional space of understanding and sometimes even cooperation throughout the process.

5. CONCLUSION

Conversion to OF&F supposes transformations in farmers' practices as well as in their representations, values and links to various social networks. Conversion to OF&F is an exemplary case for broader analysis of changes in agri-food systems (Lamine & Bellon, 2009). We have emphasised the role of the diversity of actors disseminating a global ecologisation, because their expectations differ according

to their trajectories (Sautereau, 2009). We consider that, beyond consensus, multiple frames, strategies and involvement of stakeholders contribute to introducing more sustainability into overall agro-ecosystem design and management, with different levels of ambition regarding the reforming of the system.

Both *shading* and *distancing* processes, which are considered as the main problems of our agri-food systems, could in some sense be solved if agricultural-structural changes could return to more diversified farms, crop rotations, smaller production units, and a closer integration of crop and livestock enterprises. But doing so is difficult to accomplish since there are huge investments and sunk capital costs involved, occurring not only at the farm level but across the entire commodity chain, from inputs through production, processing, and marketing (Princen, 2002). OF&F enables an increased transparency of production processes and promotes bottom-up governance, but unless this transparency is extended to include more social relations, its potential to effect fundamental change will be circumscribed. Other alternatives are appearing, such as the trend to consider agro-ecology as a prototype of sustainable agri-food systems, emphasising stronger linkages between social and environmental components (Wezel et al., 2009).

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Chapter 3. Coexisting Organic Standards: Setting Boundaries, Navigating Multiplicity and Enacting Commonality

Maarten van der Kamp¹

Abstract

While the certification of ‘sustainable’ food products has gained prominence as a way of organising the transition to more sustainable forms of agriculture, little is known about how standards are reproduced through everyday activities and the role of individual actors in this reproduction. I attempt to account for these processes by exploring the dynamics between standards and markets. Using the concepts of market device and the singularisation of products, and based on my empirical study of the reproduction of organic agricultural standards in the UK, I argue that the distributed enactment of standards results in a multiplicity of markets which is characterised by a fragmented common space and boundaries that can only be partially maintained. While this space and these boundaries do allow for the singularisation of products, this requires a number of resource-intensive activities: simplifying issues for consumers, actively playing down differences from consumers and within supply chains, and coordinating mechanisms not embedded in the standards. I conclude that standards do not ‘standardise’ practices but help to organise them: ‘sustainability’ standards shape different forms of agriculture, depending on the local practices and coordinative structures which are mobilised to regulate them.

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1. INTRODUCTION

Although the regulation of food has a long history, the independent certification of properties falling outside regulatory control is a much more recent phenomenon. Mostly, these properties are specified by standards developed by organisations that present themselves as advocates of more sustainable practices and lifestyles (e.g. fairtrade, organic). Standards in this category – and the labels associated with them – have emerged as an additional mechanism to coordinate practices of different actors: consumers are encouraged to change their patterns of consumption, manufacturers are offered a particular image and access to a premium market if they change their production processes, and producers of raw ingredients are given the opportunity of reaping better rewards for their produce if they alter their farming practices. The positioning of these standards indicates that they are intended to radically alter the way in which food is produced, processed and marketed. As a technology therefore, these voluntary standards are aimed at reshaping economic, social, institutional and cultural relations.

In mainstream discourse on sustainability standards, externally validated compliance with standards is framed as providing a convenient mechanism for organising and governing markets for ‘sustainable’ products and services. Yet this does not mean that in practice standards are neutral and value-free tools for the optimal resolution of technical aspects of sustainable practices. On the contrary, recent studies (e.g. Schmidt and Werle, 1998; Bowker and Star, 2000; Busch, 2000; Timmermans and Berg, 2003) have illustrated how standards incorporate social, political and economic interests, and therefore how, as profoundly social objects, they shape social and material relations. The use of voluntary standards for the creation of a more sustainable form of agriculture (however that may be defined) therefore has implications that stretch far beyond debates comparing the relative merits of one system over another in supposedly ‘objective’ terms. In other words, understanding the conditions under which a system innovation (c.f. Elzen *et al.*, 2004) based on ‘sustainability’ standards functions, requires a detailed look at what these standards do and how this is achieved. This is not so much to do with how the resulting type of agriculture is environmentally, socially or economically more sustainable than a referent system, but with how standards shape social and material relations within their agricultural system and the relations with a referent system. Such analyses have the potential to describe the social, political, organisational and ethical consequences of standardisation and certification of ‘sustainable’ products and practices. They are therefore essential to uncover the potential as well as the limits of voluntary standards for achieving a transition to a more sustainable agriculture.

While there are many accounts, in the social science literature on standards, of how standards are made and maintained, and how they shape economic and organisational connections (e.g. Liebowitz and Margolis, 1995; Brunsson and

Jacobsson, 2000), few studies consider the effects that standards have on socio-material practices and vice-versa. The ways standards are reproduced through everyday activities and the role of individual actors in this reproduction therefore need to be accounted for.

In this chapter, I address this question through a detailed examination of the way in which organic standards are enacted in the UK. Such studies open up multiple perspectives; my current focus is on the dynamics between standards and markets. The paper is organised as follows. In the next section I suggest that this dynamic can be conceptualised in terms of standards as a market device, a socio-technical arrangement through which a market is constituted. I also suggest that the process of singularisation is useful in conceptualising the construction of boundaries between markets.

I argue that the market device fulfils two main functions: the standards construct a boundary between conventional² markets and organic markets, but at the same time ensure that organic markets are compatible with one another. I then briefly introduce the settings of organic agriculture in the UK and the empirical basis of this paper. I argue that the distributed enactment of standards results in a multiplicity of markets, which is characterised by a fragmented common space and boundaries that can only be partially maintained. While this space and these boundaries do allow for the singularisation of products, this requires a number of resource-intensive activities: simplifying issues for consumers, actively playing down controversies and internal differences from consumers and within supply chains, and coordinating mechanisms not embedded in the standards. I suggest that standards do not 'standardise' practices, but rather help to organise them – that 'sustainability' standards shape different forms of agriculture depending on the local practices and coordinative structures, which are mobilised to regulate them. Finally, I conclude that while the use of standards constitutes a system innovation for a more sustainable agriculture, standards simultaneously restrict the potential for innovation by limiting the space for other innovations to emerge, and that innovations in constituent practices are no longer possible.

² I use the term 'conventional' to refer to farming systems that are based on the use of chemicals and fertilisers – and what is mostly taught as mainstream approaches in agricultural Colleges. Although Belz (2004) refers to this as 'industrialised' agriculture this is not a very accurate term, as organic farming practices have emerged from and draw on industrialised agriculture, in so far as there is a high degree of specialisation and a reliance on technology (even if some forms of technology are eschewed). These characteristics are especially noticeable in the recent emergence of 'intensive' organic systems. I took the term 'conventional' from my respondents, who used it to denote the mainstream farming systems from which the organic sector is distancing itself.

2. STANDARDS AS A MARKET DEVICE

2.1. From quality definition to market device and singularisation

The fundamental difference between markets for ‘sustainable’ and conventional products is the presence of enforced regulations or standards that add a quality to produce. This quality will influence some specific aspects of consumption, but not others: a consumer may prefer to buy an organic carrot for its ‘sustainable’ credentials, but this will not substantially alter the way in which the carrot will be cleaned, chopped, cooked and eaten. Put differently, the effect of an added quality is most prominent in the form of a market segmentation – once a consumer has bought a carrot, organic or otherwise, its trajectory will not differ based on the additional quality.

However, standards do not ‘just’ exist: they are set by certain actors, adopted by others, their adoption is verified by yet another set of actors, and their presence affects how actors within a supply chain relate to ‘qualified’ products and services. This points to two specific processes that form the basis of what standards do: they coordinate elements in a socio-material landscape, the result of which is (or can be) used to differentiate between products. In other words, standards specify some properties of objects and processes, and thereby coordinate technical elements of practices. They qualify these coordinated elements by drawing on a moral economy through which difference from conventional objects and processes is constructed.

Although both processes have been theorised from various sociological, anthropological and economic angles (e.g. Katz and Shapiro, 1985; Brunsson and Jacobsson, 2000; Egan, 2001; Henson and Reardon, 2005), these accounts are limited in that the market is conceptualised as a given entity, i.e. standards supposedly help organise an economic reality. As such, the accounts fail to analyse how markets are reproduced through practice and therefore do not theorise how the dynamics of enacting standards shape (aspects of) markets (for a brief overview of a practice-based approach to markets see for instance Araujo *et al.*, 2008, or for a longer argument for the study of the enactment of markets see MacKenzie, 2009). For the purpose of this chapter I therefore mobilise two concepts, which specifically address the enactment of markets (c.f. Callon, 1998). The concepts of market device and singularisation are powerful tools to analyse how markets are ‘performed’: they draw attention to the ways in which markets are constituted through different sets of practices.

To conceptualise the way in which standards coordinate elements in a socio-material landscape, I draw on the idea of a market device as proposed by Muniesa *et al.* (2007). These authors see this as a specific form of economic arrangement, i.e. a socio-technical *agencement* that enacts particular forms of being ‘economic’ (p. 4). In other words, a market device is the arrangement of actors, institutions and objects through which specific objects or processes are

rendered 'economic', where Muniesa *et al.* emphasise the 'rendering' rather than what 'economic' should mean. They argue that the meaning of 'economic' in the context of a particular *agencement* is the outcome of a process of "economization" which is historical, contingent and disputable. Thus, market devices are "...objects, instruments, tools and techniques (i.e., technologies in the largest sense, that enable market activities)" (Muniesa, 2008: 291). For instance, Sjögren and Helgesson (2007) discuss how different pharmaceuticals and treatments are made commensurable, i.e. economised, through the concept of the Quality-Adjusted-Life-Year (QALY). The metrology of the QALY mediates between different pre-existing drug classification schemes and allows policy makers to determine which treatments will be reimbursable. Therefore, the QALY as a market device allows for a comparison, on an economic basis, of differently framed treatments: through a historical, contingent process different treatments have become economic (exchangeable) within the space created by the QALY. Other examples of market devices include pricing equations, which contribute to the construction of financial markets (MacKenzie, 2006), or telephones, which configure how trade takes place in trading rooms of financial institutions (Muniesa, 2008).

2.2. Market device and sustainability standards

Applying the concept of market device to a socio-technical arrangement consisting of standards and the associated complex of actors and objects, implies that, unlike the QALY, sustainability standards introduce an additional quality on the basis of which a completely new set of markets is created. More specifically, an existing market is redefined as 'conventional', and in parallel a similar market emerges which is 'qualified'. The main point is that the presence of standards makes the conventional market fundamentally incompatible with the 'qualified' market: conventional products are by definition excluded from the 'qualified' market.

Thus, by coordinating a socio-material landscape through classification (Bowker and Star, 2000), standards create markets and simultaneously erect boundaries between those markets and the 'unqualified' markets. However, as suggested above, they go further. If a standard governs more than one market (for instance the organic standards govern arable and livestock agriculture as well as aquaculture and processing), all of these 'qualified' markets become compatible: products from one market can serve as input for products in other markets (this is similar to what the QALY does). This coordination of markets by the market device stems from the fact that standards specify properties. As the technical properties of objects and practices are thus specified, these objects and practices become compatible – which means that they can circulate in the common space defined by the standards.

The differentiation process is about making the boundary between conventional and 'qualified' products visible to consumers and actors within supply chains. It

involves actors such as those setting the standards, those adopting them and those verifying they have been adopted, as they qualify products and processes within what Callon *et al.* (2002) termed an ‘economy of qualities’. These authors argue that competition in an economy of qualities is structured by the singularisation of products and consumers’ attachment to or detachment from goods. Put simply, singularisation consists in making something familiar or recognisable. But this process of letting something (a product) stand out requires a basic resemblance with other products: “[t]he singularization of a product, which allows its attachment to a particular consumer, is obtained against a background of similitude” (Callon *et al.*, 2002: 203). Hence, the visible presence of an additional quality, such as a standard or its associated label or logo, helps to make a product singular in a particular way: this product was produced in accordance with additional standards – in the case of ‘sustainable’ products, emerging from moral principles – whereas another, similar product, was not. This implies that the process of singularising products reproduces one or more boundaries and therefore suggests that the socio-technical constellation through which standards and regulations are enacted is an integral part of the creation of parallel markets³.

2.3. Organic farming standards: a practice-based approach

Although these concepts do shed some light on how constellations of actors are involved in enacting standards and markets, they do not elaborate on the specific practices through which boundaries are created and maintained between conventional and ‘sustainable’ markets, and compatibility is organised within ‘qualified’ markets. In the next section I therefore describe how these processes function, based on my empirical research on the enactment of organic standards in the UK.

My study explored how organic standards are reproduced through coordinated sets of local socio-material practices by different relevant groups of actors, therefore focusing on a number of arrangements of everyday activities, objects and knowledge required to make the organic standards ‘come alive’. The following account is a brief sketch of one of these arrangements, and is based on in-depth, semi-structured interviews with eighteen key informants: organic farmers, agricultural consultants, researchers and policy makers from the organic sector. I furthermore interviewed and observed the daily work of twenty

³ One might suggest extending the analytical framework of this chapter by drawing on the work of Neil Fligstein, whose neo-institutional framework would introduce the dimension of standards drawing on key institutions (governance structures, concepts of control, rules of exchange, and stability and change of markets). This would allow us to account for the way in which levels of collective reputation shape the economic dimension of standards, and the way in which principles underpinning the standards shape multiple conceptions of quality. While I acknowledge that this could be a valuable addition to the paper, I have not incorporated these suggestions as the intersection of Fligstein’s neo-institutionalism and the performative framework of Callon *et al.*’s economic sociology would introduce numerous tensions, the resolution of which would extend significantly beyond the scope of the current paper.

employees (inspectors, certification officers and technical managers) of one of the four certification bodies operating throughout the UK, and witnessed the inspection of a licensee, a seed processor. The final source was documentary evidence in the form of publicly available policy and research documents. The interviews lasted between an hour and three hours, and were fully transcribed. Transcripts, field notes and documents were then analysed to derive common themes.

In what follows, at least two relevant groups affected by organic standards are noticeably absent: retailers and consumers, who were not part of my study. Yet they obviously have an important role to play in shaping organic markets: retailers provide a limited shelf space through which all sorts of conventional, organic and otherwise (morally) singularised products reach the consumer, and consumers relate to these products in differentiated ways. Both groups of actors are involved in the shaping of organic markets: retailers by offering (limited) choice and consumers by choosing between varyingly singularised products. For both groups, the presence of the label or logo through which a product is singularised as organic – and the public debate through which the label is shaped – is the starting point to decide what to offer and what to choose. In fact, generally speaking their decisions are of crucial importance for the economic viability of a singularised sector and for individual producers in this sector. However, they only play a marginal role in the construction of difference between conventional and singularised ‘sustainable’ products: retailers may emphasise this difference in marketing products, and consumers attach subjective meanings to these differently singularised products which may or may not coincide with the differences constructed by the actor who set the standard (see for instance Eden et al., 2008a, b), but both processes presume the presence of a perceptible difference—a logo or label on a product. The focus of this chapter is to explore how this difference is constituted in relation to the markets that are performed through it.

3. CULTIVATING EXCLUSION: ORGANIC FARMING IN THE UK

“But for an inspector coming along is it easy to verify which one is which and which variety, physically do they look different?” (MvdK)

“No. No, they look identical, except that maybe the organic [grain] will have more weed seeds in it, in the sample, and the non-organic will be a cleaner sample, maybe. Having said that all the crops go through a cleaner so by the end of it, it should be fairly similar.” (Farm manager)

From the moment a crop is harvested and cleaned, there are few ways, if any, of distinguishing whether it was grown organically: it is impossible for consumers, and even for processors in a supply chain, to assess how a product was grown.

Thus, the visible application of the label 'organic' is the only way through which products can be singularised on retailers' shelves and throughout supply chains.

3.1. The regulation of organic standards in the UK

In order to protect consumers from fraud and malpractice, use of the term 'organic' has been regulated by law. Although there were a number of standards for organic farming in operation in the 1970s and 1980s, these were administered by private bodies and therefore had no legal status. The first European regulation was issued in 1991, which defined the term and the basic conditions for organic agriculture. So farming according to organic standards is both voluntary and regulated: in principle it is a producer's own choice whether to produce organically or not (although constraints like commercial pressures may not always make this a voluntary choice), but once the decision is taken to do so, the production processes are governed by standards embedded in regulations.

In the EU member states, the EU regulation is to be administered by a Ministry (usually of agriculture), which is ultimately responsible for the appropriate implementation of the organic standards within a country. However, the day-to-day processes involved in verifying compliance of farming practices with the standards are mostly delegated to an independent organisation, which has the authority to issue certificates for compliant producers. On the basis of this certificate, licensees can label their products 'organic'.

Due to specific historical processes, the administration of organic farming standards in the UK is based on a market approach. While the origins of the organic movement go back more than a century, the first formal set of standards was issued in 1967. The Soil Association, founded in the UK in 1946, issued these standards to help farmers to apply the organic principles as set out by its founders. Over time, the standards developed and became more extensive as more and more elements of farming practice were prescribed. In parallel, the Soil Association became an advocacy organisation in the public domain, which led a number of farmers to split off and establish their own organisation to support and administer the standards (Organic Farmers and Growers). Over time, more organisations emerged offering standards and certification services to members. By the time the first set of European regulations were drafted in the late 1980s and early 1990s, largely informed by the consensus between the UK standard bodies about what the minimum organic standards should be, a number of different schemes already existed in the UK, the continuation of which was accommodated in the EU regulations.

At present, the ministry in charge (DEFRA) has formally devolved the day-to-day administration of the standards not to one but to a number of different private schemes. As such, DEFRA oversees private schemes by authorising them, and provides the resources through which they coordinate common interpretations

of the standards. The unique aspect of this arrangement is not so much the fact that there are different certification bodies, but that each body is allowed to add its own standards to the minimum. In other words, DEFRA requires each of the eight schemes in operation to administer the European regulation as the legal minimum, but beyond that each scheme can stipulate additional standards against which practices will be assessed. Most notably, two schemes, the Soil Association and the Biodynamic Agricultural Association, have additional standards which are regarded as more stringent than the legal minimum. Some of these additional standards are prominently marketed in the public domain with claims that these schemes for instance provide better animal welfare and restrict the presence of GMOs even further.

3.2. The many textual versions of a standard

As such, there are multiple versions of the organic standards. They share the basis of the EU regulations, but beyond that vary in their interpretation of how organic agriculture should be practised. Therefore, producers have access to different channels through which they can singularise their products: as Soil Association organic, Biodynamic (Demeter) organic, or 'plain' organic. Being certified, for example, by the Soil Association may require compliance with standards exceeding the legal minimum, but in return provide additional benefits in the market due to the Soil Association's stance on animal welfare. This suggests that the certification bodies are in competition with each other over what their respective versions of the standards offer producers. Yet for most farmers this seems less relevant than other factors:

"I honestly think that most farmers are making choices based on what they know their neighbours to be doing, or in some cases looking at the cost of the certification scheme rather than a detailed consideration, what the differences and standards are. I think the standards are too long and complicated for most farmers to spend a lot of time making contrasts, so if their neighbour says something they'll go with it or if their adviser says something they'll go with that." (Researcher)

For producers in the smaller nations of the UK, social identity is an additional dimension involved in the choice of a scheme: this researcher added that, over the last few years, farmers in Wales and Scotland had chosen a regional scheme specifically because the scheme is operated for Welsh or Scottish producers.

But social networks and the cost of the schemes are not the only deciding factors. My respondents described how, in general, farmers navigate a complex world full of general and specific farming practices, regulations, European and UK agricultural policy measures, standards, and markets for products as well as services. In attempting to coordinate some of these elements and to manage their implications for the characteristics of individual farms, farmers, consultants,

contractors, managers and NGOs take on varying roles and provide a wide range of services to one another. Farmers can buy services ranging from technical expertise and agronomy to marketing support, and from equipment and manpower to administrative services. In this field, certification bodies, dedicated sector organisations, trade associations and mainstream service providers are competing on different levels of activity and with different levels of competence. To help producers manage some of these complexities, some of the organic schemes offer additional services that are offered alongside organic certification, such as general farm assurance/management schemes and access to advice⁴. This is attractive for farmers, as in a combined scheme multiple certificates are assessed during a single inspection, thereby reducing the number of inspections. For one of my respondents this was enough of an advantage to remain licensed with a certification body while being dissatisfied with the organisation's failure to support her on certain organic matters.

These points suggest that social, political, economic and operational considerations seem to be more important for farmers than the technical details of what each set of standards offers over and above EU regulations. Therefore, rather than there being a market for standards, there is a market for services surrounding certification. The standards are not in direct competition but can coexist as each certification scheme provides a slightly different package. EU regulations provide the common basis around which the different schemes can connect (a point I will return to below), but other than that each individual set of standards is dominant in its own package.

3.3. Enacting standards in practice

This is not to suggest, however, that interpretations of how organic agriculture should be practised are not relevant. According to a consultant, farmers who actively choose between different certification bodies do so on the basis of their 'ethical' stance towards organic farming. He suggested that where organic principles guide a farmer's choice, he/she is likely to choose higher standards, but where organic is a means for a farmer to access a market, he/she is likely to choose lower standards, especially if he/she does not supply to consumers directly. This was echoed by a number of respondents:

“So there's a tension there between producers who are driven by the organic principles and who use the standards as a way of supporting and being able to achieve those principles; and producers who are just looking to access the market and the standards are a necessary hurdle to get over but they're not particularly worried about going any further.” (Researcher)

⁴ Certification officers and inspectors are prohibited from giving advice to licensees. However, the Soil Association has a dedicated advisory team, which is organisationally separate from its licensing activities.

“So, you have [...] the people who really take the principles to heart and say the true road is the only one we should go. You’ve got the Soil Association, who are a bit below that. They certainly go far beyond the minimum standards but they still see the practical issues. Then you’ve got a few people, you’ve got another, you then grade down through that to people who are looking at it very much more on a commercial basis” (Policy maker)

This suggests that the ways in which standards are enacted differ. In other words, whereas for commercially minded producers compliance with standards is a means to market, for producers for whom there is an ideal organic system to work towards, the standards provide guidance on how to get to that point. As such, this leads to the enactment of different ‘organics’. But while these producers still draw on the same sets of standards, there are other ways in which different ‘organics’ are enacted:

“That provides quite an interesting issue for debate at the moment as to who owns the organic idea. Is organic just defined by the standards and the regulations? Is there any other concept of organic that is separate from that? There is a group which will say ‘we are uncomfortable with the way organic is now reflected in standards, but we believe it should be more than those’ ... People talk about ‘beyond organic’ as a sort of phrase. ... It seems to me this division between certified organic and other more radical ideas is a matter of degree rather than a fundamental split but that’s one of the debates that’s ongoing.” (Researcher)

“... there’s quite a lot of Eastern European, Eurasian organic arable production that is very dubious in terms of the certification and I don’t mean that in terms of ‘oh well, it’s conventionally produced and they just falsify documentation and sell it as organic’. There is quite a lot of evidence that natural grass land is being ploughed in order to produce cereals ... [but] it isn’t what I would consider to be organic in terms of there’s no fertility building, there’s no rotation of the land ... I see that as an exploitation of natural resource which doesn’t for me fit very comfortably with the organic principle.” (Merchant)

Thus, there is a multiplicity of ‘organics’—they “are more than one but less than many” (Mol, 2002: 55). Some versions are codified by standards, but there are also ‘organics’ which are enacted at a distance from the standards. Yet when relating to consumers, most differences between varying standards and approaches to implementing them are played down so as not to confuse consumers (although some specific differences in codified ‘organics’ are emphasised towards consumers, e.g. Soil Association welfare standards):

“Yes, which is where the danger is, that the consumer doesn’t care about the plethora of standard bodies, it just wants to buy organic food and it thinks it’s all

the same and it thinks it's all organic. ... because if we give the consumer all this confusion they're just going to walk away.” (Consultant)

Many respondents made similar comments, which suggests that competing over standards is difficult: most differences between schemes need to be played down when reaching out to consumers.

Thus, boundaries within the organic sector are played down so as to protect it from losing consumers to schemes perceived to be less ambiguous (such as free-range). Contrastingly, the boundaries between conventional agriculture and this essentially homogenised image of organic agriculture are emphasised by concealing certain aspects of authorised practices. Some respondents gave specific examples of this: the fact that animal feed rations could be partly non-organic (due to shortages in organic supply), and the ways in which conventional marketing mechanisms (which, to some, did not always reflect organic principles) had become part of organic trade in response to supermarket pressure. The merchant concerned with the marketing mechanisms suggested that all actors in the organic sector had “become part of the conspiracy” so as not to “undermine what the organic brand is”. He suggested that disentangling organic products from their ‘conventional’ (and essentially anti-organic) market structures would be near impossible as this would inevitably lead to the disqualification of a substantial range of products, which would damage consumer confidence in organic agriculture. In contrast, the consultant who talked at length about the feed issue suggested that the organic sector would need to inform consumers about the way in which the current standards allowed non-organic elements in organic production systems – mainly to pre-empt negative publicity which would damage the organic sector. He described current practice as ‘near organic’ and argued that the separation between organic and conventional should be complete rather than partial. These points seem to suggest that the spread of ‘organics’ depends on a coherent term even if the enactment of these organics in local practices is very different.

3.4. The organisational fabric of transactions

At this point it is important to note that qualification and specification through the standards do not constitute ‘qualified’ markets, which are completely independent from their conventional counterparts. In fact, there are still strong interactions between them. For instance, the price fluctuations of organic cereals over the past five years have followed the fluctuations of conventional cereals. Various respondents indicated that although there are a number of specialised merchants who trade only organic produce, large quantities of organic produce are marketed by large traders who trade mostly conventional produce and for whom organic is a niche market. This implies that while in principle and from a technical standpoint the standards constitute specific markets, the organisation of trade in these markets strongly links conventional and organic markets.

The differences between multiple 'organics' within supply chains need to be managed on a more practical level. Moreover, there is not one single organic market, but many different markets that need to be made compatible. As such, the different organics need to be managed throughout supply chains. The EU regulations form the basis for this, and my respondents indicated that actors regard certified organic ingredients as unproblematic within the supply chain. In other words, trade within supply chains is managed on a practical level by reverting to the legal minimum – all products are singularised as 'plain' organic. Therefore, the regulations coordinate between different organics by providing common standards through which different, partly overlapping markets become compatible. However, as the Soil Association and Biodynamic standards are in some areas higher than the EU minimum, there are issues of equivalence for some products. For example, if a product is to be sold as Soil Association certified, all ingredients must be in line with Soil Association standards – including the chicken or egg coming from a producer licensed by a different certification body. This is resolved by an abbreviated checklist of items, which other certification bodies need to have checked while inspecting their licensees. There are sometimes tensions around this process, but it seems that differences in 'organics' have been negotiated away at least as far as the supply chain is concerned.

But the coordination provided by the regulations is not complete: while the practical trajectory of crops and products is made possible by regulations and equivalence checks, this does not mean the associated markets are coordinated. For example, some respondents commented on how there is a disparity between the supply and demand of organic cereals and protein crops for the dairy and beef industry. They suggested that the organic dairy and beef sectors grew rapidly, but that the arable sector was not able to grow accordingly⁵. As a result, non-organic protein and cereal crops were allowed to be used as livestock feed, making it harder for organic producers to find a market for their crops. One consultant argued that this had 'stunted' the development of the organic cereal sector. He suggested that if the growth of the markets had been coordinated, this would have resulted in a more balanced organic sector – although the sector as a whole would have grown slower. This suggests that the common space delineated by the diverse organic markets – the organic sector – is fragmented beyond their disparities in size and growth. Several respondents described how they attempted to provide coordination mechanisms so as to help producers navigate this fragmented space.

For instance, to address the opacity that characterises organic market transactions, a marketing organisation is trying to coordinate market transactions so that there is more transparency in the supply chain and so that farmers can make a reasonable profit while leaving others in the chain with equally reasonable profits. To improve the quality of advisory services available to farmers, a group of consultants is trying to coordinate the level of advice that

⁵ Converting cattle-based enterprises to organic is fairly easy, especially compared to converting arable operations.

farmers can obtain by setting standards for advice on organic farming. Consultancies host events to coordinate the sharing and exchange of knowledge between farmers and consultants. The certification bodies are coordinating the interpretation of common standards so as to maintain the integrity of the standards and ensure that farmers are inspected in a comparable way. DEFRA is trying to coordinate the administration and implementation of standards, and the ways in which the organic sector is supported. The two main research centres for organic agriculture are trying to coordinate research being conducted and the way in which information and knowledge are disseminated, as well as trying to coordinate discussion groups among farmers so that knowledge is shared.

Although not all of these coordination attempts are aimed at the same level, their presence implies that the actors involved want to provide some kind of coordination or control in areas related to the standards but where the standards do not reach. In other words, there are a number of actors that (with different levels of success) employ coordination mechanisms so as to structure various aspects of organic farming: social (e.g. research centres), economic (e.g. marketing organisation), technical (e.g. consultancy) and political (e.g. certification bodies) – beyond the coordination mechanisms embedded in the standards.

4. CONCLUSION: ENACTING STANDARDS, MULTIPLE ORGANICS

The findings of my research illustrate some of the ways in which standards as a market device enable market activities: enacting standards has direct implications for how markets are constituted. It is clear that from a theoretical perspective standards could be considered a very strong market device in that they make ‘qualified’ products fundamentally incompatible with ‘unqualified’ products. However, as the empirical case shows, enacting a market for ‘sustainable’ products through standards is not quite as straightforward. The multi-sited reproduction of different versions of the standards results in a multiplicity of organic markets—a horizontally and vertically segmented array of markets and practices which require additional coordination mechanisms so as to maintain their compatibility—and indeed a multiplicity of enacted ‘organics’. While the market device is based on a supposedly unified set of standards, the resulting boundaries with other markets, and the constructed compatibility among ‘qualified’ markets, are homogenised only to a limited extent. In other words, the distributed enactment of standards results in a multiplicity of markets, which is characterised by a fragmented common space and boundaries that can be maintained only partially. This space and these boundaries do allow for the singularisation of products, but to do so require a number of additional activities to be performed by various actors: simplifying issues for consumers, actively playing down controversies and internal differences from consumers and within supply chains, and providing coordination mechanisms not

embedded in the standards. A crucial aspect, here, is the need to remove or suppress the multiplicity of organic standards at the final stage of marketing as part of a 'totalising' strategy to format market exchanges (Araujo *et al.*, 2010: 236) so that 'organic' can be constructed as a homogeneous entity, which provides clear and distinct benefits.

This raises some important points about the enactment of 'sustainability' criteria of food and farmed commodities through the use of voluntary standards and their certification. The reproduction of organic standards is necessarily distributed due to the specific practices that constitute them and that are performed by different actors: farming in particular ways, inspecting and certifying licensees, coordinating activities, setting standards, trading produce, advising producers, playing down certain issues while emphasising others, etc. As such, the resulting multiplicity of ways in which different 'organics' are enacted is unavoidable. I therefore argue that standards do not 'homogenise' practices or create uniformity, but rather that they may help organise local, socio-material practices: in their capacity as market devices, 'sustainability' standards can shape different forms of agriculture – or more precisely a related set of agricultural systems – depending on the local practices and coordinative structures which are mobilised to regulate them.

This implies that the use of standards constitutes a system innovation for shaping a more 'sustainable' agriculture, insofar as standards provide a device through which many actors, objects and practices are mobilised to enact a version of agriculture that is 'qualified' on the basis of a moral economy. In other words, the standards allow for the mobilisation of an entire sociotechnical arrangement to reshape practices and objects according to a set of principles. At the same time, they close down innovation spaces: there is only a limited number of differently singularised ranges of products that can be accommodated on retailers' shelves, and as such successfully singularised versions of 'sustainable' agriculture reduce the space for other innovations to mobilise their own arrangements. Constituent practices are moreover constrained in how they can be performed; the number of interpretations of how to 'do' farming has been drastically reduced. Instead, innovation has turned into tinkering: finding local solutions to particular practical problems that the standards pose.

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Chapter 4. Bridging incompatible regimes: how the formation of intermediary regimes drives system innovation

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Abstract

System innovations, which comprise changes in socio-technical networks, rules and routines governing particular fields of practice, are generally regarded as essential to a transition towards sustainability. Various researchers have tried to unravel the pathways of system innovations in order to understand how these innovations can be stimulated or facilitated as part of transition management. This chapter aims to contribute to knowledge on system innovation pathways by studying the development of care farming as a cross-sector system innovation. Care farming is a rapidly expanding form of multifunctional agriculture that combines agricultural production with an offer of day-care to a diversity of clients. It emerged when a few pioneers started to provide care services at their farms and successfully integrated the different regimes governing the rather distinct fields of agriculture and care. Since then, the number of care farms has increased substantially. A new intermediate care farming regime has evolved, comprising new rules and routines, and embedded in regionally and nationally organized care farmer networks that are increasingly acknowledged by the healthcare sector. Our findings suggest that, at niche level, farmer strategies of (individual and collective) alignment and self-empowerment facilitate the development and maturing of a new regime. At regime level, supporting pioneers, creating room for experimentation, and looking beyond sector borders are factors that contribute to the successful realization of system innovations.

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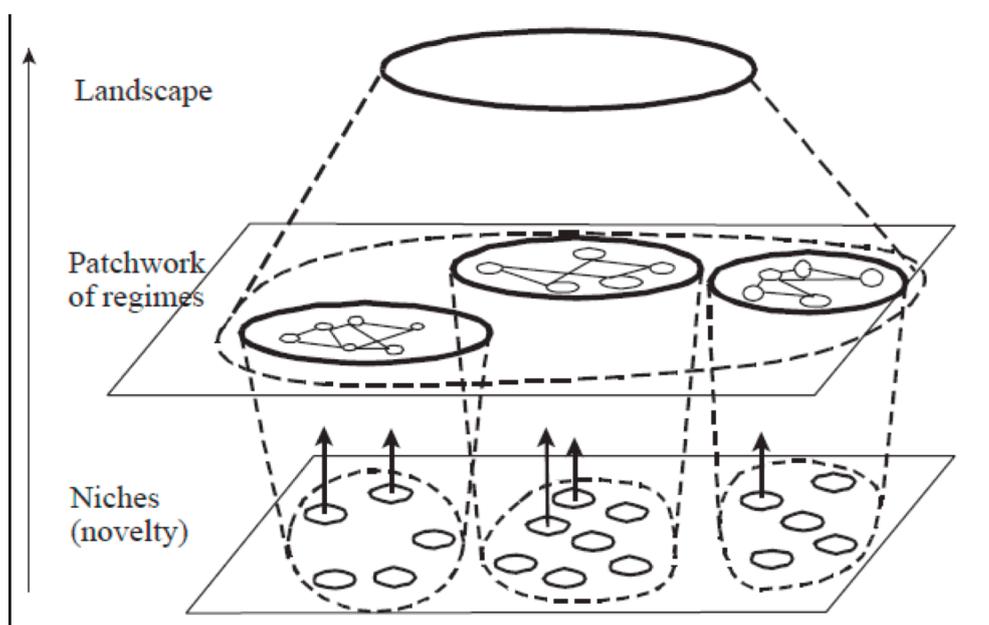
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1. INTRODUCTION: CARE FARMING AS A MANIFESTATION OF SYSTEM INNOVATIONS AND REGIME CHANGE

Contemporary agriculture faces a range of persistent problems, such as environmental pollution, loss of biodiversity, water depletion and world food problems. These problems involve complex systems of closely interacting physical, biological, and social processes as well as a diversity of actors. They are thus multidimensional and involve a multiplicity of actors. Addressing and resolving these problems therefore requires a multidimensional and multi-actor approach, which ultimately leads to the innovation of an entire socio-technical system, a so-called *system innovation* (Elzen et al., 2004). System innovations are generally seen as key to achieving sustainability. For that reason, both researchers and policy makers are increasingly focusing on system innovation processes.

Because of their multidimensional nature and the multiplicity of actors involved, system innovation processes are however far from straightforward. In order to understand system innovations, several researchers have studied historical system innovations retrospectively. A conceptual framework, the Multilevel Perspective (Rip and Kemp, 1998; Geels, 2002; 2005a), has been developed based on historical descriptive research and is nowadays commonly used to understand and explain system innovations. This framework conceives of a system innovation as the outcome of process interference at three levels: the '*niche*' level of individual innovative practices, the '*regime*' level of dominant 'rule sets', and the '*landscape*' level of long-term, exogenous trends and structures, such as political or demographic structures, cultural changes and infrastructure (see Figure 1).

Figure 1: Increased structuration



Rip and Kemp (1998) define technological *regimes* as “rule-sets or grammar embedded in a complex of 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.” Following Geels (2004, referring to the structuration theory of Giddens), we generalise the concept of regime as largely taken for granted, shared rule sets that structure and are deeply rooted in social and technical practices as routines. A dominant regime thus reflects a shared way of thinking and acting (Zijderveld, 2000) that governs a particular actor network and that sediments into a more lasting socio-material ordering (landscape). In line with Giddens (1984), Geels (2004) distinguishes three types of interactive rule sets: regulative rules, such as formal laws and regulations; normative rules, including norms, values, role interpretations, and codes of conduct; and cognitive rules, such as belief systems and paradigms.

The term *system innovation* refers to comprehensive regime changes, i.e. changes in prevailing shared rule sets and routines in actor networks governing particular fields of practice. Regime change and system innovation can be induced by mutually reinforcing dynamics at niche level, through the development of unusual, novel practices in protected spaces challenging prevailing rule sets, and at landscape level, through structural developments. The breakthrough of innovative practices at regime level can for example be facilitated by socio-cultural or political changes which force a regime to ‘open up’ to, incorporate and institutionalize novel practices (Smith et al., 2005). Wiskerke and Van der Ploeg (2004) offer well-documented examples of niche creation and novelty production in agriculture, which entail the co-evolution of technical and institutional change (Roep and Wiskerke, 2004).

In order to gain more insight on how system innovations can be accomplished, researchers have tried to unravel the pathways of system innovations. For example, Berkhout, Smith and Stirling (Berkhout et al., 2004; Smith et al., 2005) have proposed a typology that is distinguishing four ideal types of pathways: endogenous renewal, reorientation of trajectories, emergent transformation, purposive transition.

Geels and Schot (2007) have constructed another typology of system innovation pathways, by distinguishing the timing and the nature of multi-level interactions. They identify four main pathways (transformation path, de-alignment and re-alignment path, technological substitution, reconfiguration pathway). In addition, they describe a fifth possible route that sequentially combines those pathways and that could be followed when the landscape changes slowly but steadily. In these typologies, system innovation pathways are described as processes of adaptation of a regime’s prevailing rule sets to the needs of promising and socially desirable technologies. A dominant regime can change gradually over time by adapting or substituting some of its rules or routines to accommodate novel practices; it can change more radically by incorporating new rule sets for novel practices; and ultimately a new regime can emerge that can co-exist or compete for domination with the ‘old’ regime. Within innovation and transition

studies, regime or institutional changes are often thought as being driven by technical innovation; although the co-evolution of technical and socio-technical change is acknowledged (e.g. Geels, 2005b), institutional innovation is rarely recognised as a prime driver of (technical) change.

In this chapter we present a case study that effectively reflects this type of change, governed by institutional innovation: the development, scaling up, professionalization, and institutionalization of care farming in the Netherlands³. This case originated at the interface between two different and, until then, more or less exclusive regimes in two different domains. Care farming is a rapidly expanding form of multifunctional agriculture that combines an agricultural production context with the delivery of different forms of day-care services to a diversity of clients, such as people with mental or physical disabilities, individuals suffering from mental health issues, youngsters with developmental disorders or learning difficulties, and demented elderly. The emergence of care farming as a new system was initiated by a few pioneers, who intended to integrate care activities on their farms. Today, care farming has developed into an essentially professional intermediary sector, integrating agriculture and healthcare activities in a new, intermediary regime involving newly developed rule sets, including the routinization and institutionalization of care farming practices. This newly developed intermediary regime bridges the two initial more exclusive regimes by adapting new rules and practices to some of the prevailing rules, on the one hand, and developing new rule sets to fill the 'institutional void' (Hajer, 2003) between the two regimes, on the other. However, despite this co-existence, by virtue of its very existence the intermediary regime may further challenge the prior regimes, which might open up new opportunities and provoke further change in (multifunctional) agriculture as well as in health care.

As argued in this chapter the case of care farming, which shows the development of an intermediary regime favouring cross-sector system innovation, can contribute to further understanding of the relationship between regime change and system innovation, and the pathways these processes might follow. In the next section we elaborate on the development of care farming. We then describe the challenges faced and the strategies adopted in the maturing process of care farming. We conclude by discussing new insights on system innovation pathways.

2. THE DEVELOPMENT OF CARE FARMING

Although historically, in the Netherlands, mentally or physically disabled people and people with psychiatric problems have often been taken care of at farms, it

³ Various terms have been used to refer to this phenomenon: social farming, green care, and farming for health (Hassink et al., 2007). In this chapter we use the term 'care farming', which refers to all kinds of agricultural enterprises offering day care to a diversity of clients.

was only over the last few decades that care farming developed and was professionalized into a rather successful (sub)sector. The number of care farms in the Netherlands has increased considerably, from 75 green care farms in 1998 to 944 in 2008⁴. Care farming practices provide positive results with respect to enhancing customers' quality of life. Characteristics that contribute to the specific value of care farming, as mentioned by both clients and care farmers, are the structured day-programmes, the presence of (and work with) animals, the diversity of relevant activities in a real rural setting, the (green) space and quietness of the natural environment, and the personal attention provided by the care farmer (Ferwerda et al., 2008; Hassink et al., 2007).

The first official care farms were established by a few individual farmers who started to offer care at their farms for ideological reasons. These farmers can be considered as niche pioneers who had innovative ways of thinking and acting in a rather protected space – their own farm. They had to find their own ways of dealing with the healthcare regime, manifested in financial compensation routes, quality standards, ways of communicating, etc. However, changes within both the agricultural sector and the healthcare sector, as discussed below, strongly facilitated the transformation of many more farms into care farms.

2.1. Agriculture and Healthcare in transition

Following World War II, the Dutch agricultural sector was increasingly successful in terms of productivity, product quality, and efficiency. There was a strong focus on increasing production volumes through scale enlargement, specialization and intensification of land use (Roep, 2000; Van der Ploeg and Roep, 2003). However this strong intensification of agriculture came with a number of problems and societal concerns, such as the loss of nature and landscape values, increasing environmental pollution by mineral fertilizers, manure, and pesticides, high energy use, and poor animal welfare (Harms et al., 1987; Hodges, 2003). Since the 1980s, national and international political awareness of these issues have led to the introduction of a number of conditions and restrictions seeking to promote environmentally- and animal-friendly agricultural production (Moynagh, 2000; Ministry of Agriculture, Nature and Food Quality, 2008). As a result, farming costs have risen while returns on products have decreased due to the ongoing globalisation of agricultural production, leading to the agricultural squeeze (Van der Ploeg and Roep, 2003; Van der Ploeg, 2006). Moreover, the growing social awareness of the issues of environmental pollution and animal health and welfare has resulted in greater social pressure on farmers, questioning their social 'licence to produce'. Dimmer economic prospects for average-scale farming and the demand for a renewed social legitimacy have urged many farmers to search for new entrepreneurial strategies and alternative sources of income. One of the strategies that has been followed by a continuously growing group of

⁴ See www.landbouwzorg.nl, May 2008

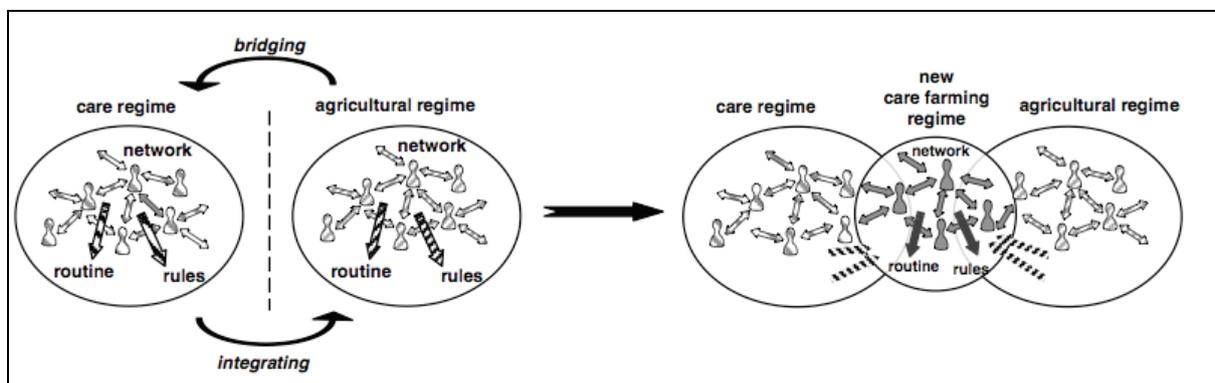
farmers is to capitalise on new social demands through the provision of additional products and/or services that could generate extra income (Van der Ploeg and Roep, 2003; Oostindie et al., 2006, Van der Ploeg, 2008). A new paradigm has emerged: multifunctional agriculture, which contributes to re-connecting agriculture with society and nature.

The healthcare sector has also experienced exponential growth and technological sophistication since WWII. The rapid development of knowledge on antibiotics (Penicillin) and pharmacology has shifted the attention to curative measures and led to the invention of a growing range of drugs. Furthermore, ongoing scientific and technological progress have allowed for the development of increasingly sophisticated medical technologies in care, treatment and laboratory research (Gelijns et al., 2001). Meanwhile, the expansion of medical knowledge has led to the ongoing specialisation of medical disciplines, and to an increase in society's trust and faith in the power of medicine and a dominant focus on physical health that neglects broader aspects of well-being. However, technological developments and the resulting continuous inflow of better and more expensive machines, tools, treatments and medicines have caused an uncontrollable increase in healthcare costs. Since the 1980s, the focus of healthcare policy has therefore shifted from the expansion of services to the reduction of costs. This has resulted in a number of new regulations and agreements and the self-regulatory role of the health care sector, in which Health insurance companies are assigned the role of watch dogs (Van der Maas & Mackenbach, 1995; Exter et al., 2004). In the 1990's, this focus on cost reduction was gradually accompanied by renewed attention to environmental and preventive measures (Van der Maas & Mackenbach, 1995) and a demand for the re-socialization of healthcare (e.g. through continuous volunteering). As the unidirectional focus on cost reduction had resulted in long waiting lists and inequalities in care provision, Dutch healthcare policy reflected growing concern about healthcare accessibility and quality. While care quality was long defined by evidence-based effectiveness, care is increasingly defined as meeting patients' (individual) demands. The growing empowerment of clients and patient organizations has reinforced this trend. As a result, various attempts have been made to shift the traditional supply-driven orientation of healthcare towards a more demand-driven framework (Saltman, 1994). In 2001 this led to the introduction of the Personal Budget (PGB), a new form of healthcare reimbursement within the framework of the Exceptional Medical Expenses Act (Algemene Wet Bijzondere Ziektekosten; AWBZ), which deals with funding long-term and chronic care. The PGB allows clients to purchase their own care, without any specific requirements, thereby providing a fairly adequate method of funding care farming (Exter et al., 2004; Hassink et al., 2007). Moreover, the focus within care for people with chronic diseases, mental health problems, or intellectual disabilities is shifting towards the encouragement of patients' individual autonomy and self-realization, resulting in many efforts to (re-)integrate them into society (Van Weeghel et al. 2005; Schols & van Schriek-van Meel 2006).

2.2. The rise of care farming

The transitions in agriculture and healthcare reflect developments at both landscape and regime level which together have created (and still provide) a 'window of opportunity' (Geels, 2002) for the breakthrough and evolution of care farming. Pressures on the agricultural sector (global competition, sustainability requirements, animal diseases, competing claims, animal welfare) have urged farmers to look for other entrepreneurial strategies, while changes within the healthcare sector (demand orientation, socialization of care, demand for holistic and personal care, ageing of the population) reflect new opportunities for alternative care settings. The integration of a care branch in the agricultural enterprise is proving to be rather lucrative for many farmers and to contribute to the social legitimacy of the farm. At the same time, the farm-bound care offered seems to meet new demands in the healthcare sector, by offering small-scale, client-centred care in an informal but real societal setting. The establishment of the Personal Budget, reflecting an institutional change, provided a smart link between both sectors and an important catalyst for care farming to further expand. Furthermore, the development of care farming was encouraged by the government with the establishment in 2000 of a National Support Centre for Agriculture and Care by the Ministry of Agriculture and the Ministry of Health. This support centre has been serving as an expertise centre for all parties involved for the last eight years.

Figure 2: The rise of care farming as an intermediary regime



In this context, over the years, the number of care farms has exploded. Meanwhile, care farmers have organized themselves into national and regional societies and study clubs, developed new routines, and established their own quality assurance system. Within their professional context, they have proven able to bridge and harmonize the formerly exclusionary and highly incompatible regimes of agriculture and care, partly by adapting daily farming routines to rules that dominate health care practices. They have ended up constituting a new intermediary regime that incorporates elements from both regimes, as well as newly defined rules and practices (see Figure 2).

However, the process of bridging exclusionary regimes and building a new regime is not an easy one. Care farmers have faced and still face many challenges. In the following section we elaborate on these challenges and on the strategies adopted by farmers to overcome them.

3. THE DYNAMICS OF CROSS-SECTOR SYSTEM INNOVATION

3.1. The challenges

A major challenge that confronted the first care farming pioneers was to be accepted, acknowledged and adopted by the healthcare networks. They had to fight to become granted a place in these networks by other network parties and to receive financial compensation for the care services they delivered. Even today, a number of care farmers still struggle with this. The establishment of the PGB significantly relieved this problem since care can be provided to clients that have a personal budget, independently of the recognition by care institutions and other care professionals.

Another significant challenge is to bridge the gaps and incompatibilities between the rule sets governing the different regimes. These include: formal regulatory rules; normative rules, such as norms, role values, role interpretations, and codes of conduct; and cognitive rules, such as belief systems and paradigms (Geels, 2004). Many rules within both the agricultural and the healthcare sectors are based on the basic needs of the actors involved: clients, animals, farmers, other employees. These needs have been translated into formal regulations or informal codes of conduct. However, in some cases rules and needs for optimal agricultural production or animal welfare are incompatible with rules or needs relating to client involvement in production or client safety and vice versa. Moreover, rules that seek to prevent or deal with the outbreak of animal diseases are usually not compatible with the combination of agricultural production and care. Conversely, rules that aim to guarantee care quality generally risk hampering the integration of agriculture and care.

On a more informal level, differences in normative rules – such as norms, values and routines – as well as in cognitive rules – such as beliefs, paradigms, and languages – may also hinder regime crossing. The hierarchical and bureaucratic world of healthcare sometimes collides with the more flexible and pragmatic world of agriculture, which impedes effective communication and collaboration. Similarly, the approach to clients differs significantly. In healthcare, clients are predominantly regarded as people who need effective and efficient care because of their disabilities or illnesses. In care farming, they are predominantly treated as equals who have certain potential for development and growth.

3.2. Strategies for cross-sector system innovation

In order to meet these challenges, care farmers develop and apply several individual strategies:

- proper self-reflection on their own capabilities, preferences, perspectives and priorities concerning the type of services to deliver and the kinds of people for whom they should cater;
- adequate management of relationships and networking with care institutions, local and regional governments, other care professionals, fellow care farmers, etc.;
- an adequate PR strategy and the mobilization of their own supportive network, consisting of professional 'allies' or of clients' enthusiastic parents or partners;
- the provision and dissemination of a certain level of professionalism, for example by achieving the quality mark for care farming, attending specific educational courses or employing professional care providers on the farm. This increases the confidence of and strengthens relations with other care professionals and care institutions;
- seeking support or advice from fellow care farmers, umbrella organizations, consultancies, etc.;
- the adaptation of farm and animal housing, farming equipment, daily activities or farm management, in order to be able to comply with rules and demands for care quality and client safety (see also Ferwerda et al., 2009).

One strategy to bypass confrontation with the healthcare network and its rules is to seek some sort of independence from care institutions, for instance by welcoming clients with personal budgets only.

In addition to individual strategies, care farmers develop and apply collective strategies that contribute to the acknowledgement and embedding of care farming in the care sector:

- collaboration and creation of a national branch organization, regional societies, study clubs, and other networks. The national branch organization was initially established and supported by the national government, in order to stimulate the development of care farming. In regional structures, care farmers jointly undertake certain activities (PR, negotiations with care institutions, the development of management systems, etc.). These branch initiatives partly relieve individual care farmers from administrative and networking tasks, and especially help to develop care farming into a more professional activity and an equal party in negotiations with care institutions. Furthermore, the established (regional) networks provide platforms for knowledge exchange and mutual learning;

- increasing professionalism of the new sector, for example by organizing specific educational courses and a quality assurance system, set up and managed by the sector itself. The quality assurance system for care farming is currently being adjusted to the Dutch national norms for care quality (HKZ norms);
- building scientific evidence on the added value of care farming for clients, the healthcare sector, and society as a whole. This effort is expected to make a decisive contribution to the political legitimisation and wider social acknowledgement and institutionalization of care farming. Until now many people have believed in the value of care farming, but scientific evidence is still lacking.

All these care farmer strategies can be considered as attempts to *align* newly developed rules and practices within their own regime, with the rules and routines of the other (in this case healthcare) regime, and/or as instruments for *self empowerment* by means of network/relationship management, and greater professionalism and organization. Together the strategies have contributed to the evolution of a new, intermediary regime that consists of new formal and informal networks, and new rules and routines, which are increasingly acknowledged and embraced by both original regimes. For example, the majority of healthcare professionals is now convinced of the added value of care farming as a complementary form of small-scale care that needs to be embedded into healthcare chains. Within the agricultural sector, care farming is increasingly regarded as a way of finding new sources of income and acquiring social legitimacy, thereby enhancing the sustainability of the sector. In this way, the emerging regime is gradually influencing both original regimes.

4. REFLECTION AND DISCUSSION

In this chapter we have described a specific pathway of system innovation via the construction of an intermediary regime, at the interface of two previously exclusionary professional regimes. We defined a ‘regime’ as a largely taken-for-granted, shared rule set that structures social and technical practices as well as actor networks.

Of course one could argue that people always have to deal with different, sometimes exclusionary regimes, reflecting their different roles in daily life and referring to the different communities and networks they take part in. However, over and above all these diverse regimes in daily life, within their professional practice, pioneering care farmers were confronted with two different, sometimes highly incompatible, professional regimes that could prescribe contradicting rules.

Reflecting on our findings, we identify roughly three phases in the process of system innovation via the construction of intermediary regimes:

▪ **The initial bridging of regimes.** In this phase, at niche level, pioneers develop novel ways of bridging and uniting formerly exclusionary regimes and of achieving a certain degree of acceptance.

▪ **The formation of an intermediary regime.** New shared rules, routines and practices are developed and professionalized. These routines and practices do justice to the characteristics of the original (agricultural) regime and make explicit links to main elements of the regime to be entered (healthcare). In addition, new formal and informal networks are established and professionalized. Alignment and (self-)empowerment strategies play an important role in this phase.

▪ **The maturing of the regime and the sedimentation of novel practices.** As the intermediary regime becomes even more robust and socially embedded; care farming practices eventually become entrenched at landscape level, reflecting more lasting, structural change. As such it will be fully accepted by the original regime, and will even influence its rules and routines. This maturation is facilitated by governmental support as well as continued organization and professionalization. This might, in turn, create new windows of opportunity and thus reinforce the maturation and sedimentation.

This three-phase process largely coincides with the three-step process described by Kemp and Grin (2008), of (1) 'co-existence' of new and old niches and regimes, (2) 'scaling': dissemination and consolidation of the new regime, and (3) 'anchoring': embedding in other structures and cultures, and mutual reinforcement of structural and cultural elements. Since the newly developed care farming regime influences rules and practices in both agriculture and healthcare, the system innovation resembles a form of 'effective reformism' as described by Roep et al. (2003).

Although it is becoming robust, there are still some uncertainties around the new care farming regime. Not all care farmers and other actors involved applaud the far-reaching professionalization of care farming. They fear the 'danger' of care farming developing into a new type of institutionalized care resulting in the loss of some of its specific valuable characteristics such as the small scale, the personal approach, and the participation of clients in real society. In addition, the discontinuation of the agricultural production branch is considered a risk. For some client groups, participation in agricultural production strongly contributes to their personal development and quality of life.

This case study of cross-sector system innovation processes is hard to interpret using the typologies proposed by Berkhout et al. (2004) and Geels and Schot (2007). The most significant incongruence is that, while both typologies focus on the replacement of regimes, in the development of care farming there is no replacement since the new emerging regime continues to co-exist with the former regimes. At the same time, elements of the typologies can be recognized. From the agricultural perspective, the initial emergence of care farming somehow reflects a reorientation of trajectories or a transformation path

instigated by pioneers and supported by changes at landscape level,. These changes consisted of pressures on the agricultural side (income squeeze, limited expansion possibilities, animal diseases, personal physical problems) and opportunities on the healthcare side (personal budgets, demand for small-scale, personal and socialized care). Later on, when governmental support explicitly encouraged the further development and professionalisation of care farming, the system innovation process presented aspects of a purposeful transition or a technological substitution. From the healthcare perspective, the system innovation started externally and, to some extent, represented an emerging transformation.

Our case has shown the following:

- Cross-sector system innovations start with the action of isolated pioneers within a certain regime who develop new practices arising out of the encounter with another regime.
- In cross-sector system innovations, regimes need to be bridged first at the level of novel innovative practices, developed in protected experimental space or niches. Then, gradually, an intermediary regime is developed and institutional voids are filled. Finally, maturation consists of the further structural social embedding of the new intermediary regime at landscape level.
- Cross-sector system innovations (like all system innovations) benefit from changes and pressures at landscape level. In our case, pressures on the agricultural regime urged farmers to search for alternative entrepreneurial strategies, while changing trends in healthcare provided new opportunities, together creating a window of opportunity that facilitated cross-sector system innovations. At the same time, the healthcare sector urged care farmers to formalise and justify their rules and routines, and thus to make their new regime explicit.

Moreover, cross-sector system innovations need some 'room for experimentation'. In the case of care farming this was provided through the establishment of the Personal Budget as an alternative, unconditional form of financial compensation for care services:

- governmental support, in the case of care farming embodied in the establishment and financing of a National Support Centre for Agriculture and Care, can accelerate the development of a new regime;
- successful entrepreneurial strategies to contribute to a successful cross-sector system innovation are (1) the alignment of the newly developed regime to the rules and routines of the yet unfamiliar regime, and (2) self-empowerment through the organization of networks and professionalization.

Finally, the lessons above suggest that cross-sector system innovations can be facilitated deliberately by combining the following strategic interventions:

- adopting novel, sector-crossing practices of the pioneers;
- supporting and creating room for experimentation at institutional level;
- involving actors operating in different regimes in order to explore new, promising transcending links;
- organizing governmental regulatory and financial support, and mobilizing political pressure to support and promote promising novel practices that challenge prevailing regimes and vested interests;
- stimulating new regime actors to organize and professionalize themselves.

A combination of these actions might be effective to help pioneers bridge initially exclusionary regimes, to stimulate the development of a new intermediary regime, and to subsequently enhance system innovations. The establishment of a new regime and the realization of a system innovation will likely affect the initial regimes, inducing further regime changes and creating new windows of opportunity.

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PART II

Intervention with Design

Chapter 5. The art of ‘doing’ sustainable agricultural innovation: approaches and attitudes to facilitating transitional projects

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Abstract

The management of projects for sustainable innovation is characterised by a variety of intricacies. Facilitators play a central role in dealing with these challenges. Adopting an empirical approach, this chapter discusses the practical approaches and attitudes that facilitators develop to deal with such challenges in the domain of agricultural innovation. To that end, the paper presents a list of four intricacies inherent in running projects that seek to enhance sustainable development, based on the literature: 1) the challenge of combining the ambition of sustainable change with the need for responsiveness in facilitating processes of joint planning and design; 2) the need to develop and use knowledge in a practice-oriented manner in an often science-oriented context; 3) the need to develop an innovative ‘niche’ within a context of vested powers; and 4) the need to reach beyond a project’s duration to ‘anchor’ the dynamics by which its ambitions may be realized in the future. Three cases of managing projects for sustainable (agricultural) innovation are described, highlighting the practical ways in which the respective facilitators in each case deal with the four identified challenges. It is found that attitudes developed by a facilitator differ per project yet that similarities can be identified. Differences can be observed mainly between approaches in facilitating projects that seek to explore the notion of sustainability in terms of guidelines for future practice, and projects that aim at developing concrete implementable designs. Within these two types of projects, facilitators are seen to be engaged in a continual balancing act between two identifiable attitudes: a responsive, serviceable attitude, through which the facilitator seeks to connect with participants and to be responsive to their needs and wishes (called a Learning approach here), and an attitude of leadership, through which the facilitator decides more or less alone on the way the process is to move forward (dubbed here a Leading approach).

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1. INTRODUCTION

The post-WWII wish for a rationalisation and scaling-up of food production in the Netherlands (and Europe) offered for a long time a mostly undisputed guidance to agricultural policy and practice. However, the associated value framework, heralding economic efficiency and unbridled growth, have met with increasing criticism over the years, especially since the 1970s and 1980s (cf. Spaargaren et al 2012). Today, the orthodox consensus on (technological) rationalisation and intensification has lost considerable ground and is being challenged by a variety of concerns over food quality and safety, environmental protection, nature conservation and animal welfare. The term 'sustainable agricultural development' has come to serve as an all-encompassing label for agricultural innovation guided by a mix of environmental, social and economic concerns.

Over the past two decades, the emphasis on fostering sustainable agricultural development has given rise to a wide variety of design practices that seek to stimulate socio-technological innovations. From a cross-case perspective, reflection on the practical aspects of 'doing' agricultural innovation on a project basis is useful, as the sustainability concept presents practitioners with the need to deal with complex challenges.

The literature on experiences regarding the practical elaboration of the sustainable development concept directs our attention to four major challenges:

- ***Concerning the issue of responsiveness, in the face of high ambition.*** In order to ensure the commitment of a collection of actors to working jointly on plans and projects for sustainable innovation, such projects need to be responsive to their needs and wishes. Running a project in a responsive manner requires that the participants' "claims, concerns and issues" be considered the "organisational foci" in the elaboration of the project (Guba and Lincoln, 1989). To bind a group of diverse actors together around a common goal in this manner is quite a challenge as it is. What adds to this challenge is the claim of fundamental change that is inherent to the sustainability concept: its elaboration and implementation may imply an "opening up" of existing routines, rules, values and assumptions embedded in the institutions and practices that have co-evolved with earlier, 'unsustainable' modes of socio-technological development (Loeber, 2004; Grin et al., 2010).

- ***Concerning the issue of knowledge, in the face of practical relevance.*** Among the dominant assumptions are ideas about the authority of science that are rooted in a neo-positivist research tradition. Key to this tradition is the axiom that true knowledge is universal in nature, and that its production is authoritative if it succeeds in disregarding the particularities of the time and place of inquiry. Less 'rigorously' produced knowledge in this perspective will be of a lower status, even though it may hold high

relevance to practical problem solving (Schein, 1973). From a practice perspective, the value of knowledge is determined by its 'fit' with the situation at hand (practical knowledge; cf. Loeber, 2004). As a result, in the actual practice of joint puzzling and of designing innovative projects, the status and value of knowledge may be a topic of dispute, as may be the credibility of the researcher.

▪ ***Concerning the issue of power, in the face of "persistent problems"***. As noted above, the problems that are addressed in innovative projects – the problems of an 'un-sustainable' development – may be considered as the 'side-effects' of modes of production and consumption, and associated geopolitical, economic, juridical and cultural structures, that for long were (and to some extent still are) considered perfectly rational and legitimate (cf. Beck, 1997). Because they are deeply entrenched in societal structures, such problems are called 'persistent' (Schuitemaker, 2010). Attempting to resolve such problems cannot leave the dominant structures unchallenged. This will evidently imply a confrontation with powers embedded in, and protective of, these dominant structures.

▪ ***Concerning the issue of 'anchoring' dynamics of change, in the face of continuity***. Because of the persistence of deeply rooted structures, the envisioned changes are not bound to take place overnight. Moreover, the concept of sustainability entails the connotation of protracted dynamics towards more viable and lasting modes of production and consumption in the long run. The idea of a long-term perspective on change is at odds with the inevitably short life of concrete projects. Therefore, any project on sustainable innovation has to somehow seek to reconcile the planning of a short-term project with the – by definition – long-term objective of sustainable development. This means that, ideally, a project not only results in concrete ideas or designs, but also seeks to help create the conditions under which these ideas and designs can be elaborated further and put into practice on a wider scale, after the project has come to an end. How does a facilitator deal with the challenge of 'anchoring' (Loeber, 2003; Elzen et al., 2012) the dynamics pursued in a project?

This chapter addresses the question of how facilitators of innovative (agricultural) projects deal with these challenges. We focus on the facilitator (or alternatively, the 'project manager'; role descriptions will vary among cases), as he or she is a central actor in the innovation process. His or her role is to help bring a group of project participants, either from one particular organization or, as is often the case, from various backgrounds and levels of expertise, together in a collective effort on an ad hoc basis to rethink standing practices and to develop new (technological) insights and modes of operation.

The efforts at sustainable *agricultural* innovation, and the role of facilitators in this field, are of particular interest. In the domain of agriculture, the challenges of dealing with institutional inertia and power as described above are compounded

by the complexity of working with living organisms as producing units. Institutional challenges in this domain are rooted in the dominant position of product steward boards, lobby organizations and cooperation structures for market development. Other institutional challenges come from the dominant technical innovation approach, which is strongly reductionist in nature (Steenhuizen, 2004). On-farm innovations are expected to fit with the dynamics of investment cycles, land ownership and land value as dominant facilitators for investment, as well as the need to be congruent with sunk investments and the dynamics of globalised markets for fresh produce. Moreover, novel concepts can only be successful in terms of market value when the developmental conditions of the living organisms involved are met and preferably improved.

The chapter then reflects on the approaches and attitudes that project facilitators develop and apply in the course of innovation projects that focus on sustainable agricultural development. The paper's empirical focus is on three cases of innovative projects. Among these, we distinguish between two types of projects: a) projects that aim at developing ideas on how to make the concept of sustainable development operational and a 'a mode of thinking' to guide further planning, and b) projects of innovation that aim at developing concrete implementable designs⁹. These project types can be seen as expressions of the dynamics by which system innovation moves from a so-called 'pre-development phase' to a 'take off phase' in the depiction of transition pathways as developed by Kemp and Rotmans (2005). Of the discussed cases, one is of the former type, aiming at developing a mode of thinking about making the concept of sustainable development operational. In the final sections, the cases are compared and discussed.

2. ANALYSES OF CASES

2.1 Rethinking livestock production systems

In the late 1990s, a programme, known as 'Programme 348' (P348), was set up to develop ideas about how to make animal husbandry in the Netherlands more sustainable. It was launched as one of the policy responses to an epidemic of classical swine fever that hit the Netherlands in 1997 (Grin et al., 2003). This was a broad programme with a generic outlook. It chose to apply the method of Sustainable Technology Development, developed by the programme by the same name that ran in the early to mid-1990s. The method is characterised by the

⁹ The typology made here is reminiscent of Vogelesang and Wijnands' (2009) distinction between transition pathways that originate from experimentation in practice on the one hand, and those that originate in developing future visions, in order to derive at innovation experiments from these visions on the other. However, the two modes of distinguishing between projects do not overlap: in this chapter the projects aiming at an implementable design may either find their origin in practices-based experimentation or in processes of envisioning the future. Likewise, the projects aiming at elaborating the notion of sustainable development may or may not include envisioning exercises.

combination of three elements: a) it takes perceived future human needs as a starting point for analysis, e.g. the need for food in 2050; b) it propagates the development of future visions about possible practices by which these needs may be met in a more sustainable manner than is the case in the current situation; and c) it develops a method of 'backcasting', that is, of reasoning back from the visions of the future to the present situation, in order to establish what should be done in the short run to enable the development of the envisioned changes in the long run (cf. Weaver et al. 2000). P348's Core Programme Team received training in this method, and adopted the idea in order to develop novel approaches to dealing with persistent problems in Dutch livestock production.

Regarding responsiveness

Among the characteristics of the approach developed was its deliberative perspective. Stakeholder participation was made a cornerstone in thinking about and developing novel, sustainable approaches to livestock production. Yet in the practice of the eight concrete projects that were P348's spin-off, the facilitators often put an emphasis on pushing participants forward so as to avoid a mere 'optimisation' of the existing unsustainable system instead of the envisioned fundamental change of that system (Bos, pers. comm.). The project proposals that reached the Core Programme Team, in spite of the team's efforts, were rather traditional proposals aiming at "*incremental improvement* of isolated elements of livestock systems rather than on *trans-disciplinary, reflexive design systems*." (Grin et al., 2003; italics in the original). The project facilitators took the lead in setting the course and objectives of the projects proposed.

Regarding knowledge issues

The first output of the P348 programme consisted of a portrayal of various broad visions for livestock production in the Netherlands. The report (Ketelaar – De Lauwere, 2000) was richly illustrated with images of the future options envisioned. It had been written in close cooperation with some of the stakeholders. Its reception was mixed. Those in favour of the ideas expressed in the programme were enthusiastic about the report. However, it was also set aside as being "not scientific" (Spoelstra, 2002). The institutional context of the Wageningen University required a more scientific approach for the programme. This "put additional pressure" on the team members (Grin, et al. 2003: 12). A way to deal with this was to seek to translate the broad visions into much more specific options for implementable designs.

Regarding power issues

The Core Programme Team that gave shape to P348 was committed to exploring new modes for fundamentally redesigning livestock production in the Netherlands. Its remit enabled the core team to do this, as its governmental 'steering group' agreed. Yet the different contexts in which the programme was

to develop were not all set to welcome the innovations suggested. The cluster of research institutes ('DLO') to which the programme was commissioned by the Ministry of Agriculture itself was in the midst of fundamental change: its previous lump-sum budget granted by the Ministry was changed into a programme-based system of financing, most of which now had to be found among private investors such as businesses. This meant that P348's initiative to develop projects on a 'supra-institutional' basis, in which outside – and mainly non-investing – parties were to play a major role, landed in a situation that was not sympathetic to the idea. A parallel governmental programme, *Ecology Economy Technology* (EET), that financed innovative projects in and outside the agricultural realm in contrast to P348, aimed at innovation in the traditional sense of the word. The approach to dealing with this inconsistency, which put tension on the progress of the projects, was to make the adherence to stakeholder deliberation a *sine qua non* for funding through the P348 project. Commitment and engagement in this way were 'forced on' the project, so to speak, by their facilitators (cf. Bos and Grin, 2008).

Regarding anchoring

The project developed an entirely novel institutional arrangement within the context of the research institutes (now Wageningen UR) in which it was embedded. Key to this arrangement was the commitment to establishing an interdisciplinary project team and the idea that "programme interests would be considered above institutes' interests" (Spoelstra, 2002). At the time, these choices were totally unprecedented and led to a lot of stress and a tug of war between diverse research institutes about budget claims of the participating institutes and the question of responsibility. To ensure the 'anchoring' of its key principles, the project leaders of each spin-off project were made to obey certain rules such as: a project team had to include a stakeholder in addition to the research institutes' own people, and project implementation was to be done by teams that would include several research institutes (ibid.: 13). Thus, the specific nature of the P348 programme was anchored via the formal rules for acquiring research grants for agricultural innovative projects at Wageningen UR.

2.2 Energy Webs: developing cooperation between varieties of actors

The liberalisation of the energy market in 2003 provided an opportunity for the glasshouse horticulture sector to become a new player in the energy sector. Growers were allowed to exploit Combined Heat and Power (CHP) engines and to sell the excess electricity on the open market. The possibility of exchanging heat with one another was interesting for the growers when combined with artificial light (the lamps produce year-round heat so the CHP-heat can be shared with heat-requiring glasshouses). This led to a number of energy clusters among growers in the Netherlands. At the same time the technique of storing solar heat from glasshouses in aquifers and of using it for heating glasshouses in the winter

became available (Van Andel, 2002). In spite of the advantages and potential viability (Velden *et al.*, 2007), heat exchange between glasshouses and non-horticultural counterparts in so-called 'energy webs' has not developed fully, due to organizational and cultural obstacles for cross-regime co-operation. Of the 15 initiatives for energy webs that have been developed since 2003, only two energy webs are operational today.

The Energy Web project was aimed at understanding and overcoming the pitfalls in the co-operation process, and was financed by the Dutch Ministry of Agriculture. The project was set up as action-based research and supported three initiatives. One of these was not successful. The required cooperation between a grower, a housing cooperative, a project developer and the local city council did not work out. The facilitator did his utmost. He invited all growers in the area to a collective meeting with the city council, housing developers and the participating housing corporation. The meeting was aimed at presenting technical options for the combination of glasshouses and the projected energy requirements of the buildings. As all parties were interested in further calculations, the facilitator was able to gather data and take the lead in drafting the principles of cooperation. Thereupon one grower was selected. Focusing on this grower, subsequent meetings were meant to help develop a clear view of each other's motives, the techniques involved and the implementation timeline. The facilitator was asked to continue the facilitation activities, mainly for his ability to cross cultural bridges and for his role in initiating the process. The process failed, however, when the housing cooperative was not able to build a business case on heat exchange given, the legal limitations of renting out houses in the social sector.

Regarding responsiveness

Forming an energy web was a complex process, technically, legally and organizationally. On top of that, the participants' time horizons differed significantly: the grower's context is a yearly crop-and-market cycle, with an investment horizon of a maximum of 10 years. The housing cooperative, in contrast, used a multi-year building plan, and counted on decades for exploiting a site. The grower was interested in a sustainable energy concept but was averse to taking on extra responsibilities. The facilitator helped to build an understanding between participants, by organizing visits to each other's companies and by encouraging the participants to be frank about their ideas and concerns. In addition, the facilitator kept the momentum going and, thanks to that, kept the participants excited about the process and its progress.

Regarding knowledge issues

The technical tools used in the process allowed parties to roughly calculate energy flows and economic viability. The relevance of this knowledge however, was heavily debated. Debates revolved around the reliability and relevance of knowledge, such as calculation tools and (informed) assumptions, on which to

base the business case, like the gas and electricity prices and the energy efficiency of the system. The interpretation of information could calculate the system as viable, but also as non-viable, given only minor adjustments. This made both the interpretation tool and the information itself subject to discussion. The facilitator helped the participants to interpret new knowledge in the perspective of their ambition and in view of the trust between partners. He helped them to develop their own perception of risk and to see how much risk they were willing to take.

Regarding power issues

Powerful institutes like housing developers and energy companies seemed hesitant at best to cooperate with glasshouse horticulture farmers and were obstructive at worst, leading to delays and a lack of trust in other energy web initiatives. To avoid collision, the parties focused on a relatively small-scale project that could be performed outside the influence of such institutes. The parties in the initiative thus remained in charge of the process.

Regarding anchoring

Anchoring was targeted at in three ways: firstly by designing and developing an energy web; secondly, the partners as well as the facilitator were to act as ambassadors for the concept of energy webs; thirdly, successes in the process were communicated to growers, civil servants of other cities with a horticultural connection, housing corporations, and project developers. Whereas the third type seemed to deliver some level of anchoring, in terms of further consultation of two municipalities, based on the experience in this case, the second type resulted in parties that were open to cooperation but aware of the complexity of the task, with the result that the energy web was never concretely built.

2.3. Developing a collective trade monitoring union in the pepper supply chain

The vegetable chain in the Netherlands used to be centred on regional auctions, but this changed dramatically during the mid-nineties. In the process of mergers between auctioneers in those years, auctioneers – organisations based on grower-cooperatives – also took on the role of trading organisations, often by takeover. This process of mergers and takeovers led to an increased conflict of interest between the organisation and its growers. It also coincided with an increase in power of the large retail organisations, resulting in a limited number of buyers in Europe. The central auction lost its function as a result of the arrival of multiple (grower owned) trading associations. As a side effect, product flows were no longer centrally monitored, which led to a loss of oversight and lack of control on price stabilisation, while increasing the distance between growers and the market, since trading organisations started to play a dominant role.

In addition, the position of the growers was severely damaged by European subsidies for market development (abbreviated as GMO) in horticulture, which were distributed via trading organisations and former (but still cooperative) auctioneers. These subsidies allowed such 'GMO-worthy-organisations' to invest in, for example, packaging utilities. Growers were obliged to cooperate with these GMO-organisations in order to develop products of higher added value. Within 10 years, growers had lost insight into the product streams and were now contractually bound to a GMO partner for their development.

In 2005, a number of leading growers met to seek a way out. The growers decided on hiring an external consultant to lead their process of regaining control of the market. A new alliance was formed and called P8 ('Pepper 8' – for the participating eight pepper growers' associations, collectively representing about 90% of pepper production in the Netherlands). Later this effort was copied in the tomato, cucumber and egg-plant sectors.

The first steps of P8 were (internally oriented) towards: 1) bringing structure and focus to the list of wishes and actions previously determined by the growers; 2) positioning the organization through many presentations and discussions with growers throughout the country; 3) achieving quick results to establish credibility; 4) to get insight into product streams and product quality development from the time of harvest to sales at the retailer; 5) starting a debate among growers on the nature of their problems in the marketplace; and 6) initiating an international promotional campaign for Dutch peppers. These first actions led to a base on which P8 could discuss issues of product quality and fairness of price setting with traders, and even discuss the fairness in the production chain with retailers. Over time the nature of P8 changed – from a budding alliance trying to establish new working relations between growers and the trading corporations, to an organization that tried to 'referee' such relations.

Regarding responsiveness

While P8's aim was to regain a powerful position in the market – in balance with the relatively high business risks that companies in the primary sector face –, the process facilitator felt that his primary goal was to establish an alliance that could 'face the storm' in the power struggle with parties in the market. For the facilitator in the internal organization of the growers' collective, being responsive meant dealing with wishes and emotions within the P8 board, and building trust among the growers nationally while proposing and facilitating a new organizational design. Outwardly, facilitating this process meant keeping good relations with the representatives of the challenged powers, while being able to make a stand against them.

Regarding knowledge issues

The facilitator had to work on a number of different expertise levels: getting updates and expertise on facts of market dynamics and product streams,

communication, process interventions, stakeholder interventions, understanding power structures in the supply chain, and designing organizational structures for P8 as it developed.

For growers the process involved understanding more about the nature of their position in the market and the needed attitude change to overcome this: "The availability of products has to be controlled by growers again, and this can only be done collectively." For the facilitator this phase involved convincing growers that P8's views were correct.

Regarding power issues

The project was aimed at reaching a stronger position in the market, which meant that the power of other parties in the supply chain would have to diminish. The very presence of P8 therefore caused a power struggle among the parties in the supply chain. These existing powers were challenged on aspects like quality control and efficiency, and were presented over time with a competing organisational model. Being the chairman and spokesman of P8, the facilitator had the leading role in confronting these powers. This meant debating with both the (internal) participants to have them all adopt the same strategy, and with the (external) 'competing' powers to argue the growers' case – and the un-sustainability of the current situation - and have these supply-chain parties give more power to the primary producers.

Regarding anchoring

The strategy of anchoring followed was that of uniting the P8 members and gaining their trust in the proposed strategy. The reputation of the facilitator himself became strongly tainted through the process as an ambassador as being "for the growers", which over time meant that the consultancy firm he was hired from lost clients, such as the trading organisations. The ultimate goal of anchoring was the introduction of the new market organisation. The first attempt at this has failed, but a second attempt with a different organisational design seems probable.

3. COMPARISON AND DISCUSSION

The above descriptions of the ways in which project facilitators dealt with the four challenges – identified in the introductory section as seemingly inherent to the management of projects for sustainable agricultural innovation – show quite a few similarities in the approaches developed and attitudes adopted.

Regarding responsiveness

The cases show that it is wise for facilitators to tap into the participants' needs and beliefs. To be responsive, the facilitators had to express an open attitude and genuine interest in the participants, and had to be able to deal with emotions and allow criticism and even doubt in the projects' chances of succeeding. It proved of help when a facilitator had the courage to show his or her vulnerability and uncertainties (P8).

While showing such a modest and service-oriented attitude, the facilitators in the cases described were, however, able to steer the processes beyond fulfilling the participants' immediate needs, in order to reach for more fundamental innovations. Here differences between the two types of cases can be observed. Whereas the "idea-developing projects" aimed at having participants "think out of the box", the implementation-oriented projects needed the participants to adopt and collectively pursue a new concept or design. For "thinking out of the box", the project facilitator had to help participants to find a proper balance between far-sighted designs and practical feasibility, by challenging them time and again to explore the 'margins' of what they deemed feasible. In the projects aiming for an implementable design, the facilitators consciously steered towards a consortium with a willingness to "get inspired" and work towards an aligned vision, a concrete goal (which was the reason why participants joined), and a shared strategy to achieve that goal. It was therefore a process meant to bring a sense of collectiveness around a problem or shared interests and to develop the trust needed among parties to invest time, effort and (in most cases) money. In the cases presented, trust was built by the facilitator delivering quick results, engaging in a (public) debate on the challenges the projects addressed, protecting a high level of confidentiality within the group and at times with individual participants, and providing the knowledge base on which the design was built.

Regarding knowledge issues

Acquiring new knowledge or adopting new ways of applying knowledge is at the heart of transitional projects. New applications of knowledge may be challenged by assumptions about the authority and relevance of science that are rooted in a neo-positivist research tradition. In the cases observed, the ambition of a project determined the type of knowledge issues that came up within the course of the respective cases. Within the 'idea-developing' project, quite innovative stances towards knowledge production were developed, which caused the project to clash with institutional contexts. In some projects that aimed at implementing new designs, new knowledge applications (and limited new technical research) were introduced by the facilitators to inspire participants, so that they could develop implementable concepts with a high ambition in terms of sustainability. In the P8 case new organizational models were copied from other market domains and energy web calculation tools were developed based on common practices in other sectors. The struggle on the focal point of knowledge therefore

did not revolve around the nature of knowledge (rigour of knowledge), but rather the applicability for the case at hand (relevance of knowledge). This involved a challenge for the facilitator to be well informed in proposing the knowledge application and to be trusted by the participants to extrapolate using these tools.

Regarding power issues

Both types of projects had to face the challenges of defying the self-evidence of "business as usual". The "yoke of normality" could be located partly in the institutional context and (economic, technological and cultural) structures in which the respective projects were situated, and partly in the minds and hearts of their participants who were bound to build on their experiences with that world, as were, for instance, the applicants for research funding in the P348 context. The challenge for the facilitators was to shield the project to some extent from these powers while at the same time carving out space in which their projects and resulting plans could develop. The facilitators in the cases observed used different approaches to create such conditions, given the projects' respective ambitions. The idea-focused project tended to coach its participants on areas of understanding and redefining structures and to help them observe stakeholder positions that can impact the system at hand – for change or stagnation. In contrast, the design-oriented project seemed to require a 'steering' attitude of the facilitator in terms of proposing and working towards a position of power for the group. The facilitators led the groups towards a strategy of impact within or against the system through a process of presenting analyses of the current power structures and alternative strategies. In these projects the chosen position of power was either that of avoiding collision (case: energy web) or of challenging the current structures (case: P8). In both types of cases, we can observe that the power basis depended on whether or not the facilitator was able to have the participants speak with one voice and present the group as a unit.

Regarding anchoring project dynamics

All project facilitators saw themselves faced with the need to reach beyond their project's remit and duration to try to ensure that in the future conditions would also be favourable to a project's results. The projects described may be conceived of as sites for experimenting and for technical innovation that present challenges to the dominant (socio-technical and governmental) regime. Their description shows how each particular site was used as a stepping stone to set in motion changes beyond the project's immediate results.

In the idea-developing project, the facilitators were aware of the fact that, ideally, the changes set in motion were themselves not of a one-off nature, but were dynamic in character, allowing for future changes in line with the ambitions to be developed in particular projects. A case in point are the efforts the facilitators made to develop innovative research plans by setting new conditions for funding agricultural research proposals.

In the design-oriented projects the main form of anchoring was found in the structures that were designed – an energy web or a new market organization (P8). In the process the facilitator however focused on intermediate forms of anchoring, both to use them as milestones to show progress and to have an impact beyond the design objective – an impact that was often desired by the participants. Most tangible, the following impacts were observed beyond the immediate design projects: P8 led to the formation of K8, T8 and A8 (respectively cucumber, tomato and egg plant) and the experiences in energy webs were used by growers and project participants in other energy web initiatives.

The overall findings on the facilitators’ approaches and the attitudes developed are summed up in Table 1, which compares and contrasts the two types of projects.

Table 1 - Reflections on the approaches of the process facilitator regarding four focal points, given the project ambition

Project ambition	Facilitators’ approach			
	responsiveness	knowledge	power	anchoring
Developing ideas	develops an understanding of and responsiveness to participants’ needs as a basis for pushing ideas and visions beyond their immediate reach	designs the project as a process of joint knowledge production on the basis of practice, inducing reflexivity and learning on the part of the participants	consults participants on their (individual) challenges with power structures	1) takes on the role of project ambassador and invites participants to also become ambassadors 2) actively links up project dynamics and findings with external events and developments 3) engages outsiders to take the lead in pursuing (parts of) the agenda for action developed in the project
Designing implementable structures	strives for an understanding of and responsiveness to the participants’ needs and motives to gain their mandate for steering the process towards a shared vision and an implementable design	applies (new) knowledge to design new (technological or organisational) structures. To enable implementation participants will (often) need to understand and accept the proposed knowledge application	steers towards a desired position of power of the team or project in the given context (to avoid or to engage with external powers)	1) steers towards milestones of intermediate, tangible results 2) takes on the role as ambassador and coaches participants to also become ambassadors 3) steers as directly as possible towards the new order or system

4. CONCLUSION

Comparison of the cases shows that the approach and attitudes developed by a facilitator differ for each project, yet that similarities can be identified. Among

these, the main difference that can be observed concerns the approaches adopted in facilitating a project, depending on whether it seeks to elaborate the notion of sustainability in generic terms, in order to set an agenda for further project development, or on whether it aims to develop implementable designs.

Among the differences is the attitude of the facilitators towards the idea of visions and envisioning in dealing with some of the challenges identified. In P348, the facilitator (team) looked upon envisioning as an objective of the project as such, and used it as a means to lever, so to speak, the project's general outcome beyond short-term, incremental solutions. Envisioning in the other projects was a starting point rather than an outcome, a tool to get the participants to gather in the first place. In contrast to the previously discussed projects, here facilitators worked hard to develop the idea of a *shared* vision.

A related observation concerns the attitude that the facilitator develops towards the project participants when 'facilitating' the intended processes. There seems to be a recurrent alternation between two distinct attitudes that a facilitator exploits: on the one hand, a responsive, serviceable attitude, with which the facilitator tries to connect with participants to identify their needs and wishes, and on other hand, an attitude of leadership, with which a facilitator decides (on her/his own) on the way the project is to move forward. The two attitudes can be labelled 'Learning' versus 'Leading'. Both are meant to help coordinate the project and make it result in innovative and sustainable options for sustainable agriculture. Yet while a Leading role of the facilitator requires a consultancy or 'interim management' approach – depending on the mandate given by the process partners – a 'Learning' role implies a less obvious yet equally decisive stance, aimed at coercing or 'luring' participants into new modes of reflecting and acting.

We suggest to describe the two different manifestations of attitudes displayed as:

- Learning, that is, a 'connecting' attitude through which a facilitator invests in understanding and responding to participants' needs and motivations. This connecting attitude leads to acceptance of the facilitator's role and – from the facilitator's point of view – a deeper understanding of the challenges as seen by the participants. It was typically displayed at the start of a project, in the design phase of implementation-oriented projects.
- Leading: a 'steering' attitude with which a facilitator uses the trust (or mandate) she or he has managed to generate in order to convince or persuade participants to develop more ambitious points of view, or to adopt proposed ideas, strategies or designs, or to challenge power structures.

Facilitators describe these attitudes and the subtle mixes between these in terms of 'gut-feeling'. The Learning attitude was worded differently by different facilitators, but was recognized by all. They used phrases such as "getting the wind in the sails" or "wanting to add value to others" to express this way of dealing with the challenges encountered. The Leading attitude was described as 'grabbing the helm', 'putting the participants in the right mindset' or 'captivating others'.

Finally, the alternating attitudes are not exclusive to one type of project or the other. A Leading role adopted in the design-oriented projects seemingly involved subtle forms of expressing leadership as the project went through phases such as building a consortium, adopting a shared vision, calculating the business model and eventually signing the deal. Group dynamics among the project participants oblige a facilitator to be ever so subtle in expressing leadership, in order to create trust and to build understanding among them. Likewise, a Learning role in idea-generating projects implied an extreme flexibility on the part of the facilitator, who was to help participants frame problem issues in novel terms and formulate innovative solutions that they themselves were not likely to imagine without the facilitator's involvement.

The case descriptions lead us to conclude that a facilitator is engaged in a continual balancing act between these two attitudes. Furthermore, it can be observed that the proper balance is to be found in the face of *internal* dynamics (within the project group) in regard to the 'number 1' challenge, that is, balancing responsiveness versus raising ambitions. In contrast, the balancing act is determined by issues dealing with relational power, which come up in the face of *external* dynamics.

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Chapter 6. Participatory Action Research initiatives to generate innovations towards a sustainable agriculture: a case study in Southern Spain

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Abstract

Participatory Action Research (PAR) is a methodology consisting of research and in parallel a process of social intervention. It offers an analysis of reality as a form of knowledge and awareness by the people themselves who, through this social intervention process, become active and leading subjects in a project for the development and transformation of their immediate surroundings and reality. In Andalusia, between 2005 and 2008, we conducted a PAR process with groups of farmers and consumers, in order to solve rural development problems generated by a compulsory organic certification system. Basically, these farmers and consumers were opposing a system that was not created for the small- and medium-sized producers, and that was generating their exclusion because of its costs and bureaucratic structure. Instead of applying a subsidy policy, the regional government with the Instituto de Sociología y Estudios Campesinos - ISEC (Córdoba University) proposed a more creative solution to the peasant groups. We invited them to get involved in a process where, collectively, the solution to this problem would be explored and solved. This chapter reports on this PAR process, based on the comparison of three territorial situations. We reflect on the learning process that emerged and on the social forces at play in the implementation of a guarantee system.

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1. BY WAY OF INTRODUCTION: THE NEED FOR ALTERNATIVE APPROACHES TO CONVENTIONAL SCIENCE

The analysis of problems related to natural resource management that has been done in accordance with the standards of normal science³ has often marginalised, if not ignored, non-scientific knowledge. It has tended to fragment reality and divide it into agricultural- and forestry-related technical disciplines, which are rarely related to the natural sciences. Indeed, in all phenomena related to natural resources, it has ignored the importance, in practical terms, of social, cultural, environmental and political contexts. These “extra-natural” conditions differ from one reality to another and from one time period to another. Therefore, the theories that are elaborated to explain technical-productive phenomena can hardly be universal and universalised (Guzmán et al. 2000).

In this sense, when the phenomena and realities are studied as isolated elements, they lack realism. Conversely, when they respond to a dense network of relationships, in constant evolution, they might be closer to reality. This goes not only for natural or ecosystemic elements, but also when interactions among people, creating social and cultural identities, are concerned. Noorgard (1994) called this idea the co-evolution between cultural and environmental systems⁴.

If one recognises the complex nature of reality, scientific knowledge cannot assume a closed and exact truth; instead, it responds to a scale of degrees of accuracy and closeness to reality, with errors, uncertainty and sometimes disorder. Therefore, one must not conceive a framework of knowledge superior to others when reality is studied in practice, but acknowledge the need for disciplinary and epistemological diversity (Garrido Peña, 1993: 4), recognising the advantages of multivalent logics and their pluralism (Garrido Peña, 1996: 246-261)⁵.

It is increasingly clear that conventional science has several limitations with regard to finding answers to the issues raised by sustainability in the agrarian field. The green revolution and modernisation processes have eroded the local knowledge and practices that were the fruit of a co-evolution between human societies and the ecological environment (Carson, 1964; Pimentel y Pimentel, 1979; Toledo and González de Molina, 2007). The paradigm that has sought to break with this logic of normal science separate from other sources of knowledge

³ We understand “normal science” on the basis of the writings of authors like Funtowitz and Ravetz (2000) and Kuhn (2005). Throughout this text we will use this concept as a synonym for modern science and conventional science, even though this would require more explanation.

⁴ For a more current analysis of this concept, applied to the unsustainability diagnosed during the second half of the 20th century, with a focus on natural resource management and the policy implications of this way of approaching the analysis of reality: Cf. Noorgard, 2002: 174-178.

⁵ Garrido Peña expresses this break with the hegemonic scientific paradigm as follows: “Break with epistemological imperialism of the bivalent logic and supports other ways of thinking and representing reality, within a pluralistic framework where there is no supreme court that tests cases on the truth or falsity of the different types of rationality and thought” (Garrido Peña, 1996:252).

in natural resource management has been called Agroecology. The conceptual framework of Agroecology is underpinned by a trans-disciplinary scientific approach that proposes a pluri-epistemological approach to knowledge. This means that a dialogue between scientific and traditional rural knowledge is possible and much needed, in order to conserve biodiversity and to find plural and innovative answers to the present crises (Naredo, 2006:19-46; Boada and Toledo, 2003: 9 – 39; Alonso Mielgo and Sevilla Guzmán, 1.995: 91-119). Translation of local knowledge in resource management thus becomes a pre-condition of sustainable development.

Taken into account the need for disciplinary and epistemological diversity,

The agroecological framework proposes three dimensions to account for rural and agrarian activity, all of which should be taken into account in order to build sustainable propositions (Ottmann and Sevilla Guzmán, 2004, 2005):

- The technical and productive dimension: searching for production methods that respect the environment and health, and contribute to maintaining ecological balances in the agro-ecosystems;
- The socio-economic dimension: searching to build production and consumption relationships at the local level, so that the main actors of food production and consumption gain control over the production and distribution process;
- The political and cultural dimension: stressing the need to build processes that empower main actors in order for them to create solutions that should be adapted to their local reality and culture, and that allow for profound control over the socio-economic processes relating to food provision.

Given the environmental crisis in the second half of the twentieth century, the *greening and washing* approaches and agroecological approaches certainly differ in interpretation and analysis, as well as in the ways they propose solutions. These differences can be located in the premises from which these two approaches start. Noorgard and Sikor (1995: 16) argue that Agroecology changes the premises underpinning modern science, introducing alternatives to correct its epistemological deficiencies. Instead of fragmenting reality, it tries to come closer in a holistic way; it rejects mechanistic approaches; it replaces a desire for universalism by contextualisation processes and phenomena; it rejects objectivism and assumes subjectivism as being intrinsic to human activity; and it builds knowledge from pluralism, avoiding monism.

By emphasising the need to build a sustainable society, Agroecology aims at establishing epistemological processes in order to facilitate the co-production of community and public knowledge that promote processes of “endogenous development” (Sevilla and Ottmann, 2001:35-47). In this co-production, two key elements have to be underlined: firstly, the participatory definition of objectives within the knowledge co-production process; secondly, joint participation in the process of concretising knowledge in a technical-productive, socio-economic and cultural device that, finally, has political implications.

2. TRANS-DISCIPLINARITY AND THE DIALOGUE OF KNOWLEDGE AS A PREREQUISITE FOR A NEW SUSTAINABILITY SCIENCE

Given the origins of current scientific disciplines, the co-production of agroecological knowledge is related to the concept of trans-disciplinary research. The fragmentation and specialisation of science in disciplines has been overcome through the inter-disciplinarity proposal. It points out the added value of research approaches that get together experts from different disciplines to discuss and develop research projects (Morin, 1986). But the notion of trans-disciplinarity goes further on. This perspective has spawned the concept of 'post-normal science', developed by Funtowicz and Ravetz (2000) and has been conceptualised by other authors under the concept of trans-disciplinarity (Hurni & Wiesmann 2004; Hirsch Hadorn *et al.* 2006, Kumar 2002, Turpin 2002).

It emphasises the need to project knowledge production not only beyond disciplinary divides, but also beyond the scientific arena itself. A fundamental challenge of trans-disciplinarity is to find a way that encourages dialogue and cooperative integration between the various forms of knowledge, the scientific and the popular ones (Cuellar and Calle, 2011; Rist *et al.*, 2007). Within this framework, a new typology of sciences is proposed that takes into account different levels of uncertainty, complexity and interests involved in a specific problem. These authors argue that 'post-normal' research is geared to the joint solution of problems defined on the basis of close interactions between the scientific communities and social actors involved. These problems will reflect society's highest priorities, so that research will become a process of co-production of knowledge, where scientific knowledge is one form of knowledge among others.

One way of concretising this dialogue in order to enable collective creativity is Participatory Action Research – PAR (Villasante, 2006). Through this methodological framework, the principle of dialogue between scientific knowledge and practical and local knowledge are put into practice at the level of scientific production. Reflexive processes can be developed that tend to strengthen endogenous potential in order to find solutions to problems in the agrarian field and in rural contexts.

Participatory Action Research (PAR) is a methodology developed from a dialectical perspective, consisting of research and a closely inter-related process of social intervention, in parallel. In this way, PAR offers an analysis of reality, which is a form of knowledge production and of raising awareness among the participants, who thus become active and leading subjects of the development pathways of their immediate outer reality.

The specific circumstances of each process or reality determine how it is carried out and accounted for. Despite the particularity of any given process, there are some common criteria that can be identified in most PAR processes: a) acting in order to achieve objectives that accurately match the specific problems to solve; b) operating within a given process with openness to all the points of view of

those involved, in order to achieve consensus on a diagnosis and to discuss and negotiate the proposals raised during the process; c) facilitating the involvement of participants, which is a prerequisite in order to incorporate participants' proposals as a set of guidelines for future action; and finally d) promoting the starting point of a new stage of detection of new problems, which consider new objectives, and giving rise to a search process.

3. SCIENCE WITH PEOPLE: A PARTICIPATORY ACTION RESEARCH PROCESS IN ANDALUSIA, SOUTH-EASTERN SPAIN

In Andalusia, between 2005 and 2008, we conducted a PAR process with groups of farmers and consumers, in order to solve a specific problem in this region. In 2005, three different groups of organic farmers in these territories (Sierra de Castril, Sierra de Segura and Serranía de Ronda) asked the regional Andalusian government for a solution to implement a compulsory organic certification system. Basically, they were opposed to a system that was not created for small- and medium-sized producers, and that was generating exclusion because of its costs and necessary commitment to a bureaucratic structure. Instead of applying a subsidy policy, the regional government proposed to the groups of peasant a more creative solution with the help of *the Instituto de Sociología y Estudios Campesinos* - ISEC (Córdoba University). As researchers of this Institute, we invited them to get involved in a process in which the solution to their problems would be found and an alternative proposed.

Our research work thus aimed at contributing to the creation of an alternative system that would generate confidence in these farmers' produce, thanks to a mechanism that adapted to their farm sizes. We elaborated a preliminary model of what is generally known as Participatory Guarantee Systems (PGS) (Cuéllar y Reintjes, 2009; Roure, 2007; Rundgren, 2007; Khosla, 2006). These are confidence-building systems that are working, under different structures and procedures, all over the world.¶

In this chapter we report the social changes generated in these groups thanks to this collective and participatory process, with particular attention to the three dimensions analysed: technically, through continuous knowledge exchange between the technicians, researchers, consumers and peasants involved; socio-economically, as this process strengthened localised agri-food systems in the region; and politically and culturally, as the process was based on endogenous proposals, and the success of the collective creativity generated self-confidence, empowerment and mutual support.

3.1 Methodology in use

In any PAR process, Balcázar (2003) invokes three dimensions: research, education, and action, which are reflected in a series of activities. The defining

elements of the PAR developed in our case are outlined in Table 1. PAR processes are generally driven by agents, who are external to the communities or groups in which they operate. In these cases, these external actors play a central role as facilitators of the process. Successful development of the methodology should generate a transformation thanks to the transfer of the prominence to the participants.

In the process of building a PGS for Andalusia, two principles guided the design of the methodology of this action-research:

- The three groups that had brought to the fore the problem of certification audits, and the need for solutions, were able to find the answers themselves, by way of a PAR (Balcázar, 2003: 7).
- The PAR process should promote a transformation of the social reality of the persons involved, through increased self-confidence and trust in the community.

Table 1. Key Activities of the Participatory Action Research developed

Activity	Property
Research	Analysis of the problems associated with third-party certification (through certification bodies) Evaluation of alternatives to this European mandatory system Analysis and evaluation of a participatory process of building a Participatory Guarantee System (PGS) Analysis of the PGS operability in Andalusia: strengths and weaknesses Analysis of the possibilities of building a PGS in a territory from a PAR
Education	Working group meetings in which collective critical awareness is built, and the ability to propose alternatives and solutions, in a collective way, is reached. Development of capacities of discussion, exposure of opinions and visions, and search for consensus.
Action	Construction and implementation of a PGS Responding to the needs of organisation and interaction among participants, for the implementation of the PGS, local and regional socio-technical and economic networks were established

The proposed stages of the dialectical process

The structure of the PAR in this process, following the systematisation suggested by various authors (Fals Borda, 1993; Ibáñez, 1998; Ortí, 1999, Guzmán et al., 1996; Villasante, 2006)⁶, has consisted of four stages, in addition to a previous one (Table 2).

It is assumed that each region/group should adapt the process to their own reality, in terms of specific techniques to be implemented at each stage, and depending on the objectives it wants to reach. The way to ensure coordination

⁶ The processes that arise through the PAR are neither final nor determined in advance; the hows and whos are constantly redefined (Rosa and Encina, 2003: 95).

and concomitant objectives and stages between the three groups was carried through regular coordination meetings of the technical team and expanded meetings between all those involved in each territory. These expanded meetings allowed: on the one hand, to build consensus on the elements that were at work in each of the stages, and on the other hand, to determine the objectives and timing of the next stage.

Table 2. Stages of the methodology followed in the construction of an alternative system of certification for Andalusian organic production

Stage	Objectives
Previous	Knowing the territorial context of each area Establishing a first approach to the problems
First	Agreeing on the diagnosis and establishing the first draft of proposals
Second	Building the final proposals for an alternative Guarantee System
Fourth	Evaluating the model and the process; identifying new symptoms

3.2. Assessment of the impact and changes generated by a process of science with people

The effects and changes that were generated by the process in the groups who built it were evaluated by means of a set of semi-structured interviews at the beginning of the process and at the end. Establishing a similar pattern in both stages of this fieldwork, we compared the evolution of discourses and visions of the people directly involved in the process.

The perception of the concept of “guarantee”

Broadly speaking, after the analysis of interviews, it appears that the initial vision that the people involved in the project had on guarantee systems for organic products was very narrow, in the sense that they did not imagine other possibilities or options apart from audits by a certification body, despite the widespread dissatisfaction with this procedure. They were glimpsing the possibility of proximity processes, on a local scale, which interlinked the various stakeholders in building confidence, but did not believe in their inherent ability to manage this confidence.

However, a year and a half after the beginning of the research, the prevailing vision among the people involved in the process was different. They grasped the idea that guarantee systems in organic products could be more than just a technical examination. It could be the result of a process and mechanisms of building confidence through close relationships, and through which the social context itself continuously endorsed what was being done, without the need for technical figures or annual reviews.

"The regulations must be met, but it is more a local certification system, more participatory (...) that is organised into groups, (...) It gives substance to other

things that a private certifier cannot, in my view, such as training, counseling, participatory sessions between producers and consumers (...) of course, that's what gives you more autonomy and independence and also much more support"
(farmer - Sierra de Segura)

A mechanism was constructed that they recognised as their own, with full awareness of the advantages and difficulties of putting it into practice. They were convinced that this participatory system was more reliable than the third party certification system. Several reasons were expressed to support this opinion, such as: a) the constant social control of the implied persons, which means that everybody knows how the others are producing; b) procedures that strengthen the direct relationships between the different actors; and c) procedures that facilitate continuous exchanges between producers and with consumers.

They clearly identified that the issue of legal recognition would be a serious stumbling block with possible effects on the consolidation of the system. They likewise perceived a certain immaturity of the system, identifying the need to move towards a horizontal assignment of tasks and transmission of information by all involved, as most delegation of tasks and responsibilities was still in the hands of the technicians and the research team.

Participation and confidence in the group

At the beginning of the project, some inertia in the territories was perceived, that precluded or limited the emergence of group initiatives aimed at resolving common issues. Trying to characterise this inertia, we identified two perceptions of respondents regarding their social environment: individualism, which generated distrust of others, feelings of loneliness and very little initiative to engage in group processes; and passivity, generated by the general attitude, and consisting in waiting for solutions to their problems from the government administration. In this sense, the need for rewards or incentives (such as the Common Agricultural Policy and its subsidies) was identified.

In this context, which was common to the three territories, there were certain specificities conditioning the particular development of the project in each of the areas involved. In Castril the external impulse of the process was valued very positively. The initiative for the project, despite some doubts, was well received, perhaps because it is a territory with a long tradition of working through participatory methodologies, that the University of Cordoba had been developing through the ISEC.

In Sierra de Segura, an added difficulty was perceived to question the success of the project: the huge geographical distances and the topography of the region, which would make very difficult to work at a territorial level in a participatory way, because of the distances.

Serranía de Ronda was the territory where the starting point of the project was the most negative. We perceived two peculiar issues concerning its concrete

reality, which could adversely affect the process proposed. First, agriculture is not a major activity in this region, only a source of part-time work. This meant that producers were less likely to engage in activities that their livelihoods did not depend on.

As a second specific difficulty, we perceived in the analysis of interviews a sense of frustration and dissatisfaction with local and regional administrations, related to the failure of a number of previous projects. The interviewees identified the cause of the failure as a lack of real support or accompaniment over time, or the generation of conflicts that had not been dealt with.

After one and a half years of work on a collective and dialectic process to promote dialogue and joint reflection, the reality perceived in the territories is different. Broadly speaking, we see that the level of social maturity on the project is high in Castril, medium or high in Sierra de Segura, and low in Serranía de Ronda.

However, in the three areas, the main problems detected during the process were shared and were treated by means of the innovative procedure proposed within the PAR, a dynamic approach completely unknown in these contexts. In this regard, the three project areas have demonstrated a shift from passivity to a responsible and active attitude to make proposals and to work collectively. We admit that this process of change is slow, but note that through the project we have initiated some changes.

In Castril and Sierra de Segura, participation has facilitated a process of rapprochement and communication between people, through which they have recognised shared problems in the practice of their profession. The direct effect has been to increase confidence in the group and the ability to engage in dialogue. In both areas, this process was seen as a beginning, on which to keep on working. In these two areas we have perceived the need to persist with technical support, and thus to keep on “energising the process”. This support guides the implementation of the actions that have arisen as a result of the socio-practical process.

The group of the Serrania de Ronda had a different evolution. Broadly speaking, we see that the project did not achieve a real consolidation of the group. An idea strongly perceived as a difficulty, in the second round of interviews, that was already perceived at the beginning of the process, was that agriculture is a source of part-time work in the area, and that any project that requires involvement of the primary sector will have a weak response in this area. A direct consequence was that the people who were motivated to get involved ended up frustrated and tired, because of this little social answer to the project. This generated a vicious circle that appeared to be difficult to solve.

Despite these difficulties in Serrania de Ronda, one cannot say that the project has been a failure, or should be terminated. Instead, there is appreciation for the progress that has been made, albeit at a very slow pace. Given this shared analysis, which supposes some kind of immaturity of the group, we argue that there should be deeper reflection on the facilitating support to propose in order

to continue building the process. Note that the problem initially detected – distrust in government – does not appear in the speeches during the second round of interviews. We understand that implementation of the project, established in a serious and committed manner, and with a continuous monitoring of the technical people involved, has been able to break that initial distrust but nothing more. However, this initial difficulty has been one of the causes of weaker participation of other people in the project.

3.3. Actual changes in the territory

The changes detected in the views of those involved correspond to concrete changes in the social implementation of initiatives. In this sense, the Castril group has been the most active. In summer 2008, this group had established three stalls (*Biopuntos*) in Castril local markets and nearby towns; was catering for six schools in three districts of Granada; was participating in regional organic markets (*Bioferias*) organised by the regional government, at their own stall and at the stall set up for Andalusian PGS groups; and had reached an agreement with *El Encinar*, a cooperative of organic producers and consumers in Granada city, in order to supply them with a predetermined volume of organic products at prices negotiated in a transparent manner.

In Sierra de Segura, the evolution of actions promoted by the group was similar to the Castril territory, but it began later and at a slower pace. At a meeting in August 2008, the group proposed to establish a specific place to collect products in one of the municipalities, in order to supply a consumer group through a weekly basket of products ordered online. Aiming to open the initiative to more people, the PGS group got involved in the days called *Biosegura*, held in August 2008 at Beas de Segura, through a contribution to the organisation of activities.

The evolution of the Serrania de Ronda partly explains the participants' feeling that they had not achieved the desired objectives. The low level of maturity and group cohesion achieved in Ronda has resulted in the fact that there has been no real and visible initiative by those involved in the process. While there had been some motivation to create a consumer group, by the summer of 2008 they had not fulfilled the most basic part of their commitment to act.

4. CONCLUSION

Considering the comparison of the three territories, the fact of learning from the participatory process has resulted in changing perspectives and notions concerning guarantee systems and the social environment itself. All of these have resulted of a collective process of exchanges and in the construction of new knowledge between producers, consumers, technicians and scientists. At first, the visions expressed by participants were based on a single view of the assurance process and on the personal changes that could involve the creation of

an alternative system. They expressed internal characteristics of the future model that pertained to their own individual expectations: basically participation and proximity. At the end of the process, they highlighted the features of the model constructed, and the aspects of collective processes generated: exchange of knowledge and experience with other producers, direct personal relations, and the promotion of mutual understanding and group support. The social construction of a group is valued not only by producers, but also by consumers and technicians at local level. They value the diversity of groups and the fact that each actor plays different roles in the established system.

The progress in the very concept of credibility and guarantee is to be noted. The interviewees began to think of it as a consequence of relations of trust and closeness between the people involved. In this way, they moved beyond the idea of confidence as an external technical review, and began to see it as a reflection of the legitimacy of individuals belonging to a group that had earned credibility. The guarantee is based, therefore, on personal relationships and close trust. This proximity put pressure on individuals to meet agreed standards, since disappointment would socially penalise them because it would mean not only a withdrawal of the seal but also expulsion from an environment built on trust and support.

The initial step of creatively devising solutions detected after a year and a half of work was possible thanks to a process that promoted a certain breakthrough in territories. These changes were perceived primarily in the inertia and entrenched views based on years of rural public policy liabilities and patronage.

With these results, we propose that the reality of passivity and individualistic inertia detected initially in the territories involved can be reversed through such dialogic processes. In our context it is unlikely that certain collective processes arise spontaneously or endogenously, given the inertia detected. However, as some results obtained in this investigation show, such a collective process has been promoted through participatory research methodologies. The starting point was some problems or "pains" over the territories, that were identified as intrinsic. The PAR has been shown to be flexible and adaptable to the specific circumstances. Thus, the starting point is not only to solve the problems detected, but also to identify the type of prior knowledge that the groups involved have about the subject, the level of social cohesion, inertia and *historical builders* of each area, and the socio-economic and cultural rhythms, among others. This starting point, and a trans-disciplinary methodology, can bring together local and scientific knowledge to build endogenous and sustainable answers.

Based on this remark, we have identified certain limitations to this type of induced process. We would like to highlight two of these limitations:

- **The reality of rural areas shows that agriculture is no longer a central activity.** In this sense, the lesson learned in these contexts is the need for research that links farming with other major economic sectors in the territory. Faced with the current trends of increasing rural pluri-activity

and loss of agrarian relevance and multi-functionality, the fact of taking this aspect into account may be very important.

▪ **Territories with negative past experiences have generated unresolved disputes and distrust.** It can be concluded that the development of PAR, that does not guarantee continuity in time or deep involvement of the research team, may produce perverse effects such as mistrust and apathy. Such continuity and involvement would not mean, however, that social processes to build knowledge and skills would be expected to create dependencies. They would aim at creating space and time where territories could acquire autonomy and empowerment, while ensuring and accompanying the desired social changes, which are usually slow.

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Chapter 7. Reflexive interactive design as an instrument for dual track governance

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Abstract

Sustainable development cannot be attained by technical innovation alone; it calls for a reorientation of the existing socio-technical regime: a system innovation. This implies the coordination of the distributed agency of the actors that focus on structural change, as well as activities focusing on the development of novel practices. These two ‘tracks’ of governance activities may reinforce each other in a process of dual track governance if they ‘reach out to each other’, i.e. seek to make functional connections. The paper describes a design-oriented approach to this dual track governance issue, called *Reflexive Interactive Design* (RIO). This approach is based on the idea that one can anticipate and facilitate system innovation by the introduction of novel concepts midway between broad future visions and specific novelties. Design and the design process turn out to act as a good vehicle to align processes of change both at the regime level and the niche level. The paper analyses the application of the approach in two design projects on sustainable husbandry of pigs and laying hens. These projects evolved into concrete experiments and new farms that radically diverge from the dominant practice, and have clearly contributed to changes at the level of the regime.

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1. INTRODUCTION

One of the assumptions underpinning the idea of transition (Rotmans, et al., 2001; Grin et al., 2010) is that the persistence of some problems may stem from processes, which are firmly embedded in societal structures. As a consequence, their resolution is bound to involve both innovative practices and structural adaptation: system innovations and transitions. Such change, in other words, is fundamental as it goes beyond established practices and the structures that have co-evolved with them.

A core concept to depict such changes is the multi-level perspective (MLP; Rip & Kemp, 1998; Schot, 1998; Geels, 2005). In short, it conceives of a transition as the interference of processes at three levels: innovative practices (niche experiments), structure (the regime), and long-term, exogenous trends (the landscape). Only when these different dynamics come together in particular ways may mutual reinforcement emerge as a necessary condition for achieving a transition. Grin *et al.* (2003; cf. Grin, 2006) have proposed that, given the structural nature of transitions, it is important to further develop the concept from the perspective of structuration theory. From this perspective, transitions essentially become a matter of (1) redirecting the co-evolution of structure and agency towards (2) sustainable development as a normative orientation, (3) amidst the turbulence of a variety of exogenous trends. Crucial in the process of re-orientation is reflexivity, understood as what Voß & Kemp (2006) have called 'second order reflexivity': the self-critical and self-conscious reflection on processes of modernity, in which actors reflect on and confront not only the self-induced problems of modernity, but also the approaches, structures and systems that reproduce them (Grin *et al.*, 2004; Stirling, 2006).

Coordinating this process implies the coordination of the distributed agency of the actors involved in a range of activities focused on structural change. This distributed agency must then be explored in experiments and through novel practices and, from there, contribute to structural change. While transition management tends to depart from defining structural change and the direction of fundamental change in practices on basis of a vision (Rotmans, 2005; Loorbach, 2007), the idea of strategic niche management for socio-technical transitions focuses more on change resulting from experiments in niches (e.g. Raven 2005; Schot and Geels, 2007; Elzen et al., 2005). To the degree that these two 'tracks' of governance activities manage to "strategically reach out to each other" (Grin, 2010: 232), they may actually start to reinforce each other in a process of dual track governance.' (Grin 2006; further elaborated in Grin, 2010: 265-284). In the terminology of the multilevel perspective, they are located on the regime and the niche level (two types of experiment, belonging to two different niches), as well as in between. Note that events and trends on the landscape level may influence or, often, be strategically used in all these different governance activities (Grin, 2010: 266).

In this chapter we will analyse two different cases of reflexive interactive design in animal husbandry in the Netherlands, and show how design and design practices mediate between the two tracks of niche formation and regime transformation. The main research questions are:

- What is the specific role of design concepts like these in processes of socio-technical change? What characteristics can be explanatory for their eventual success or failure in contributing to niche formation and/or regime transformation?
- To what extent does the design *process* contribute to eventual success or failure in niche formation and/or regime transformation? More specifically, how do design processes facilitate *second order reflexivity* by regime actors? And what characteristics of the approach chosen are especially important to this?

2. ANIMAL HUSBANDRY IN THE NETHERLANDS

Agriculture in the Netherlands can be seen as an exemplary success of modernisation, especially after its take off after World War II (Bieleman, 2000). Yet it has also experienced increasing pressure and criticism, already since the early 1970s (Grin, 2010: 249-264), when the first side effects of this success (over-production, emissions and losses, and over-fertilisation by manure) surfaced and became important societal issues. This is especially the case for Dutch livestock production: a series of dramatic epidemics and food scares framed the public image of Dutch livestock production as a disease-prone industry with disrespect for animals.

Since then, the sector has been confronted with a range of issues that are critical to its future sustainability. Its vast environmental footprint (both local, regional and global) is accompanied by increasing societal critique of the quality of life and health of animals, and debate on the acceptability of increasingly larger livestock (confinement) units in the rural landscape. At the same time farmers struggle to stay competitive in a liberalised global food market. Given not only the wide scope of these challenges, but also their seemingly contradictory nature, awareness is growing steadily – outside as well as inside the livestock sector – that in order to attain sustainable production a structural reorientation – or system innovation – is needed, both in production and consumption.

As emphasised above, such a process requires the – somehow – orchestrated action of multiple actors at multiple loci. However, attempts to coordinate action through the establishment of a vision on the future of livestock production in the Netherlands (Wijffels, 2001; Anonymous, 2005) have had a marginal impact until now. Despite global agreement between institutions over the need to take major strides towards sustainability, a coherent framework to align actions at the regime level and strategically manage niche experiments is lacking. Therefore, niche experiments that go beyond adaptations within the existing technological

trajectory will face considerable resistance from the incumbent regime, while the regime itself will not change its structuring characteristics as long as no viable alternatives to dominant practices exist, or are perceived to exist.

In our view, this dilemma may be overcome if we enrich the idea of strategic niche management by increasing the number of strategic connections between two tracks of governance of sustainable transitions – between the structure level (regime) and the niche level. One way to do this is by Reflexive Interactive Design, as developed and practised over the last couple of years in animal husbandry, by researchers from the Dutch agricultural research institute Wageningen UR. Reflexive Interactive Design (RIO – in Dutch) employs design and design activity as an intermediate intervention, simultaneously working on agency in experiments and novel practices and on structural changes that may help create space for such novel practices at the regime level.

3. REFLEXIVE INTERACTIVE DESIGN

RIO is an approach for *doing* reflexive modernisation (Bos and Grin, 2008). It is rooted in the recognition (Grin, 2004; Grin et al., 2004) that earlier forms of technology assessment do not fit problems that require structural change as well. It is a specific form of deliberative or participatory technology assessment (Gutmann and Thompson, 1996; Grin *et al.*, 1997; Bellucci and Bellucci, 2002) that adopts *design* of both the technical and social features of societal systems for production and consumption as its central activity and focus of deliberation. In this way, definition of both the problem and the solution takes place in a reciprocal and iterative argumentative exchange between stakeholders, and the people needed for implementation. Design thus becomes a matter of iteration between the desirable – in the sense of contributing to the desired change – and the feasible. The intended design should be understood neither as value consensus nor as a mere ‘tit-for-tat’ compromise, but rather as *congruency*: a course of action on the way in which modernisation in a specific instance should proceed, and that makes sense for each of the actors involved (Grin and Van de Graaf, 1996).

To reach congruency more is needed than negotiation and trade-off between different interests. The latter would be a repetition of the way modernity tried to solve its problems. Deliberation therefore has an important place in RIO. It should be performed so as to lead to second-order learning. Institutionally and technologically embedded assumptions, norms, knowledge claims, distinctions, roles and identities that are normally taken for granted must now be scrutinised. It should moreover support second-order reflexivity by *simultaneously* eliciting the introduction of novelties in practice, and stimulating changes at the regime level that enable these novelties to become successful niche experiments. RIO should yield a design process that produces concepts and propositions that are *radical yet feasible* enough to be realised in some form in the near future as a novelty in practice.

This combined character of radical *and* feasible is essential for the intended mediating function of design and design processes. These processes should be radical enough to question basic assumptions within the incumbent regime, and at the same time feasible enough to enable initiative by actors at the level of practice. Therefore, the concepts produced cannot and should not be mere technical replacements or a technical fix.

In recent years, Bos and others have elaborated these basic notions, originally inspired by various sources in innovation and policy science (Grin *et al.*, 1997; Grin, 2005; Grin and Van Staveren, 2007; Schot, 1992; Rip and Kemp, 1998; Loorbach, 2007; Rotmans, 2003; Weaver *et al.*, 2000). A crucial point of improvement and extension has been a far better accounting for the needs of key actors in the system to be redesigned, for both methodological and substantial reasons. Substantially, the aim of RIO is to synthesise the needs of different stakeholders (including animals) in design, rather than trading them off against one another. Methodically, needs are also the starting point in a systematic design methodology called *Methodisch Ontwerpen* (the Dutch for 'Structured Design') that is adopted in RIO. Structured Design (SD) (Siers, 2004; De Beer, 1997) aims at making the design process of artefacts like buildings and machinery more rigorous and traceable. SD emphasises rigorous analysis of the client's needs and of their translation into an elaborate set of quantitative requirements, based on traceable sources. The combination in RIO of a thorough system analysis and a structured design approach makes it especially appropriate to reduce the number of trade offs between seemingly conflicting needs, and the number of system failures that have been built up during years of co-evolution.

The general approach of RIO is built upon three cycles of activity with a feedback flow between them:

- **System and actor analysis:** systematic reflection on the current structural arrangements of the system at hand, and the needs of key actors involved. This is done analytically and interactively, in order to facilitate the opening up of the problem and the solution space (i.e. the number of possible solutions as perceived by actors) (Voß and Kemp, 2005).
- **Designing new systems or arrangements using Structured Design** (Siers, 2004). This is done in an interactive way, in order to incorporate practical and tacit knowledge, and to prevent a research bias in value incorporation. The results are feasible and attractive concepts that might be applied in the near future.
- **Anticipating niche and structural change:** strategically using concepts and reflection to facilitate effective reformism (Roep *et al.*, 2003) i.e. creation of niches, as well as proposals and interventions for structural changes in the current system that create the space for changes in daily practice.

These three cycles are not a chronological sequence, although the main focus in RIO projects will change over time from the first to the last. Due to both their

reflexive and their interactive nature, several iterative cycles may be completed over time. Problems may be redefined and proposed structures reassessed, and new actors may shed new light on the proposed solutions.

4. DESIGN AS AN INTERMEDIATE INTERVENTION BETWEEN NICHE AND REGIME

“Design” is clearly central to our RIO approach; it refers to both the verb, “to design” and the noun, “a design”. By “design” as a noun we mean tangible, visual material proposals for alternative systems or sub-systems that integrate a range of existing and new solutions in a way that is plausibly realisable in the near future, yet contain significant (system innovative) challenges on more than one dimension of sustainability, e.g. a drastically reduced environmental footprint and improved animal welfare, in combination with mid-term economic feasibility. As a verb, “design” is a process, in which knowledge, interests and values of a broad range of disciplines and stakeholders are reflexively scrutinised, translated and synthesised as far as possible, alternately by a broad range of stakeholders in an interactive fashion, and by a smaller group of less directly involved professionals pairing specific skills to a broad system orientation.

RIO shows at the same time what is actually possible and what has to be done to reconcile goals that seem to contradict one another in the short term. It can be used in setting institutional agendas at the regime level, and at the same time elicit the development of novelties and niche experiments that fit the larger picture.

In addition to this general function, the following more specific functions can be recognised, that will be shown in the cases below:

At the niche level:

- Designs suggest the further development of novelties that fit in a more encompassing and coherent trajectory,
- Designs suggest possible niche experiments and inspire niche players to act,
- Designs serve as a shared framework for several niche experiments, for identification and mutual learning.

At the regime level, designs question basic assumptions and rules underpinning the incumbent regime, and:

- Designs help in redefining central guiding concepts and norms (animal welfare / intensity), both in the sector and in the knowledge infrastructure,
- Designs provide a common agenda that is feasible enough to take concrete action on the institutional level (alignment),

- Designs provide opportunities for new forms of collaboration and alliances between regime actors.

5. THE “PIGS IN COMFORT CLASS” PROJECT

5.1. Patterns of the process

In 2001 the project ‘Diergericht Keten Ontwerp’ (Animal Oriented Chain Design) was inspired, and actively guided, by a representative of the *Dierenbescherming* (DB, the Dutch Society for the Protection of Animals), which responded to a call for tenders by Wageningen University and Research Center (WUR). The DB's proposal was to take animal welfare as the sole starting point for the design of husbandry systems for production animals. For practical and budgetary reasons the WUR interdisciplinary project team eventually narrowed down the focus of the design goal to welfare improvement of fattening pigs only.

The project team then defined ‘good animal welfare’ as the situation in which ‘the needs of the animal’ are fulfilled. The underlying assumption is that this will result in a quality of life that is experienced as ‘good’ by the animals (De Greef *et al.*, 2006). Since animals do not speak for themselves, these needs were taken from reports of a group of experts (see for instance (Anonymous, 2001). Subsequently, the project team identified the functions that are necessary to fulfil those needs, as well as the specific requirements that solutions for these functions should meet.

For the argument of this chapter, it is important to note that this specific operationalisation of animal welfare represents a specific interpretation of an inherently normative concept. This interpretation was (and still is) contested not only between, but also amongst, animal scientists, citizens and farmers. However, the needs approach to animal welfare took the debate on animal welfare to another level by stressing the goals to be attained, rather than the solutions required, thereby circumventing debates on the necessity of specific solutions (like outdoor areas and straw) that are perceived to be good for animal welfare. The project internally redefined animal welfare (as fulfilling needs using husbandry elements) and chose a specific level of ambition for the design (fulfilling the identified needs), with active support by the main stakeholder involved: the representative of the DB. These criteria were laid down in a Brief of Requirements for fattening pigs (Schouten and Groenestein, 2003), and a list of possible solutions for fulfilling the animals' needs was generated. Based on that, the project team elaborated the notion of structured design to produce a concept for a barn for pigs in which all their ethological needs were fulfilled (Groenestein *et al.*, 2003; Siers, 2004). A sketchy representation of this concept was included in a popularised magazine-like report (Welzwijs/CC, 2003). Shortly afterwards, the internal project leader translated the chosen level of animal welfare into an

air-traffic metaphor, “*Comfort Class*”, as the level between Economy and Star Class.

The magazine-like report and the accompanying design caught the attention of members of the Dutch Parliament, who urged the Minister of Agriculture to encourage similar developments and make Comfort Class the national minimum standard (Vos and Van der Ham, 2004). The president of the pig farmers' section of the Dutch farmers' organisation *LTO Nederland* publicly adopted the principles of Comfort Class by offering the Dutch government an alliance between LTO and DB to develop the idea and implement it in farming practice (LTO-Nederland, 2003). Together, they planned to build a housing facility according to ‘Comfort Class principles’ as a step in improving animal welfare in the sector. This was a unique alliance of the parties involved, who were traditionally opponents. It signalled that both organisations had taken a new strategy in dealing with society's growing unease over animal welfare in intensive livestock farming. The farmers' organisation LTO changed its tone from resistance to an approach of taking small steps ahead. DB chose to focus on helping animals living now by cooperating with and actively sustaining improvements, rather than criticising any practice that did not conform to their ideal.

Despite their public enthusiasm, neither LTO nor DB were willing or able to pay substantially for further development and construction. After a year, several (mainly public) actors supplied funds, and it was decided to build a pilot of the CC barn on one of the experimental stations of the WUR in Raalte. Economical, intellectual and public ownership would all be in the hands of the two initiators. In addition, a connected network of conventional pig farmers was established with interest for the CC-development. The explicit ambition was to use this group to translate features of the CC into practical terms, on farms.

A redesign phase from the original idea began, in which the Comfort Class principle was translated into a practically feasible construction that would allow for testing the effects on animal welfare, answering farmers' questions, testing the opportunities for practical application, and serving as an inspirational demo for pig farmers who would like to adopt Comfort Class principles in their own practice.

On 26th April 2006 the Dutch Minister of Agriculture (LNV) opened *Varkens in Comfort Class* (ViCC; ‘Pigs in Comfort Class’). ViCC (<http://www.comfortclass.nl/>) is positioned as a pig housing facility with a high standard of animal welfare since pigs can meet their ten basic needs (like feeding and drinking, resting, social behaviour, and thermoregulation). A non-expert visitor to Raalte would notice the amount of space for pigs, the daylight coming from the transparent roofs, and the pens with straw that occupy part of the space. A more knowledgeable visitor will also notice the fact that the pigs have complete tails and interact peacefully and socially with one another.

ViCC received positive attention in the general public media. Within the turmoil of public debate on animal welfare in general, and the fierce resistance on several

locations in the Netherlands against large-scale piggeries, ViCC served as a contrasting example of what pig welfare could be like. The Minister even put Comfort Class for Pigs at the heart of her new policy on sustainable animal husbandry, along with the search for partners to create a 'plus- or in-between segment' (cf. (Hoijtink, 2004) market for food produced according to sustainability criteria, with retail prices between those of regular and organic products.

After three years of testing and demonstration, the pilot phase came to an end in December 2009. It resulted in a 'soft yes' (De Greef *et al.*, forthcoming) on the question of whether the proof of principle would bring "animal welfare (quality of life as experienced by the animal) to a level that is at least neutral to the husbandry environment" of the animal – a 'soft' yes because we cannot directly assess the quality of life as experienced by the animal, and the available set of welfare indicators is currently too narrow and too rough to discriminate between conventional approaches and the needs approach applied in the experiment. Nevertheless, no welfare infringements were observed in the Comfort Class piggery, and the findings on behavioural synchronisation suggest an even more positive result.

During the last years of the project, the participating animal protection organisation (*Dierenbescherming*) developed the *Beter Leven Kenmerk* ('better life hallmark') for identifying meat products from improved animal facilities. For pigs, the standards were derived from the Comfort Class experiences.

At the festive close of the pilot project, two Dutch retailers announced they were willing to sell improved welfare meat in their supermarkets. Seven of the farmers involved in the experimental phase did test CC-principles by changing their own facilities or in the design of new facilities.

5.2. Interpretation: a practical standard

Several features are worth mentioning for the general argument of this paper. The first is the role of (visual) design in shaping a new, unique alliance. The artistic impression of the first design (Figure 3) combined a promise of much better animal welfare with a promise of possible realisation, into an attractive visual. Although the design was primarily meant as an illustration of the more fundamental take on animal welfare, without its visual representation the Comfort Class approach probably would not have caught the attention of members of parliament and LTO.

Secondly, and at least as importantly, the design was also a (visual) representation of a more abstract idea of what animal welfare is about. Part of its strength was that it derived legitimacy from translating animal welfare into needs and the accompanying requirements for animals' living conditions, drawing on scientific ethological knowledge. In this respect it created new common ground, at least for the representatives of the farmers and those of the animals. This was not exclusively due to scientific authority, as the knowledge

applied was not new in itself. More essential was the establishment of a certain level of abstraction, that enabled proper deliberation: animal welfare is not discussed and operationalised in terms of preferred *solutions* but in terms of a problem definition that took due account of the stakeholders' reasons or motives (Grin & van de Graaf, 1996).

Thirdly, by choosing a specific *level* of animal welfare and calling this Comfort Class, the project team created a practical reference that was both empirically testable and practically feasible, as well as being an anchor point for guiding societal dialogue and debate. This is reflected in the political decision to make Comfort Class a national minimum standard, and in the way in which Comfort Class is used by farmers and by the farmers' press as a reference to a general level of animal welfare, rather than a specific housing system. Finally, the clarity, feasibility and measurability of the reference allowed both main stakeholders to commit themselves.

These three features *together* constitute the potential of designs in mediating between the levels of the regime and the niche. The initial concept of Comfort Class 'talks' to the regime level, by simultaneously suggesting a *redefinition* of animal welfare on a more fundamental level (the needs), by identifying a *specific level* of animal welfare based on this redefinition, by making it *plausible* that this level could be achieved in practice, and by translating this into an *iconic visual form*. This combination allowed different regime players to form a unique alliance, and has since served as a useful, legitimate, minimum standard for improved animal welfare, both in politics and in practice.

The initial design concept at the same time suggests a framework for niche experiments. It contains specific solutions for desired functions, i.e. fulfilling the needs of the fattening pig. These solutions might be novelties by themselves (for instance: the micro-climate zones in Comfort Class that enable pigs to choose between zones and floors with different temperatures, in order to stay within their thermo-neutral or comfort zone), or be a novelty by a new combination of existing solutions. Both the CC concept as such, and the implied specific novelties gave rise to experiments in practice. The pilot of Comfort Class at Raalte was a first realisation of the concept as a whole, but was explicitly positioned by the initiators as a demonstration site for farmers to pick *specific* ideas to implement on their own farms. Farmers were not expected to adopt the whole concept, for economic reasons. Surprisingly, farmers performed experiments that required far more radical alterations to their facilities. It is expected that these alterations will be the cornerstone for a plus-segment of meat in the supermarket, as a result of an agreement between the largest Dutch slaughterhouse and the largest Dutch retailer.

6. THE HOUDEN VAN HENNEN PROJECT (KEEPING AND LOVING HENS)

6.1. Patterns of the process

The Comfort Class case, while exclusively oriented to improving animal welfare, laid an important foundation for later projects by introducing the needs approach to animal welfare into a structured design process. One of these later projects, '*Houden van Hennen*' (a Dutch title meaning both 'keeping hens' and 'loving hens'), focused on keeping laying hens. It took the needs approach a step further, by taking the needs of the three 'actors' in or around the system as the starting point for a design trajectory: the laying hen, the poultry farmer and the citizen, partly also in her role as consumer. *Houden van Hennen* strived to synthesise their needs into design, rather than trading them off against each other. Referring to (Bos, 2008; Groot Koerkamp and Bos, 2008) for an elaborate discussion of the first phase (2003-2004), we focus here on the functions of the designs of *Houden van Hennen* in later stages.

The project *Houden van Hennen* (*Houden van Hennen*, 2004) took place at a stressful time for the egg-producing sector in the Netherlands. The massive outbreak in 2003 of avian influenza spreading over areas where chicken farms were concentrated provided an opportunity to discredit the growing alternative practice of free ranging in outdoor areas, based on the risk of contamination of hens by wild fowl carrying the virus (Koch and Elbers, 2006). At the same time the sector had to prepare itself for two highly controversial regulations that were to take effect in 2006 and 2012 respectively, aiming (1) to stop the practice of trimming the beaks of chickens, and (2) to forbid the use of traditional un-enriched cages for laying hens (European Union, 1999) respectively.

Houden van Hennen thus had to operate on highly contested ground, without any consensus on the need for change. Yet it was clear to some that a fundamental shift was needed in Dutch egg production due to: animal diseases related to high stocking densities; increasingly stringent animal welfare standards; effective resistance from the animal protection movement; and very thin margins on the product. It was highly questionable whether a further optimisation for cost-reduction, control and efficiency – the route already taken for decades – would solve this multiplicity of challenges. In fact, one way to interpret the stalemate at this point is to say that the sector did not see how animal welfare concerns could be respected without jeopardising other considerations in egg production. In these terms, the project's objective was to design a production system that the various stakeholders would deem satisfying in all respects.

Thus, *Houden van Hennen* adopted a design strategy in which a small team of young researchers from various disciplinary backgrounds alternated between desk analysis and a variety of close interactions with a heterogeneous group of actors from within and around the sector: farmers; other actors within the production sector like egg traders and equipment suppliers; government officials; non-governmental organisations; and consumers. The team tried to

maximise the influence of actors on the goals of the project and the values embedded in its results, while at the same time challenging them to look beyond their immediate short-term needs and prevent the perpetuation of incumbent practice.

The end results were shaped substantively by the interactions with prospective users and consumers. Moreover, by the interactive definition of an elaborate brief of requirements, starting from the explicated needs of actors, a permanent entry point for future designs was created, allowing actors previously not involved to make their own basic design choices, instead of being limited to adapting a pre-existing complete design.

The first phase ended mid-2004 with the presentation of two new concepts for laying hens systems: the Plantation and the Roundel. Importantly, both design concepts were technically feasible in most respects in the foreseeable future, since the concepts rearranged existing technologies, rather than presupposing new developments. Economically, the concepts presupposed specific markets willing to pay more for the eggs – markets defined by the consumer groups to which these concepts were tailored.

With their uncommon design, they attracted attention in the Dutch agrarian media, and received recognition from government, civil society organisations and agricultural engineering firms. Initially however, they also met with scepticism, the fiercest of which was amongst poultry farmers. First and foremost, these farmers feared very high construction costs. Additionally, they interpreted the concepts as blueprints for future laying hen husbandry. This reflected the traditional pattern of knowledge development and transfer in animal husbandry in the Netherlands. This time, however, the concepts were not meant as a prescription, but as examples of ‘how it could be done’. Therefore *two* concepts rather than one were presented, differing in key respects (for instance the availability of outdoor access).

Therefore, in a subsequent phase, effort was put into communicating, along with the concepts themselves, the basic principles underpinning them: substantially more space per hen; spatial differentiation of functions in the system; and the possibilities of differentiation of these systems according to ethical, aesthetic and economic values of different groups of consumers and farmers, along with the promise of solutions to technical and managerial as well as marketing challenges facing the current systems.

This phase of *Houden van Hennen* led to at least three important developments: two different pilots and a policy change towards system innovation. The first successful pilot was realised in 2007 by a poultry farmer in the province of Gelderland, who participated in the original design trajectory and was also starring in a national educational children's TV programme (*‘het Klokhuis’*) on the initial project³. His *Lankerenhof* (www.lankerenhof.nl) was his own variation, inspired by the Plantation.

³ See <http://player.omroep.nl/?afID=10098388>

A second pilot was initiated in 2005 with the aim of realising several instantiations of the Roundel before the end of 2011, and marketing the eggs produced in these systems under a special brand. It was run by a consortium of a large and well-known egg trading company and an internationally operating company, which develops and manufactures complete poultry husbandry systems. This cooperation between different sides of the production chain was rather unique. The consortium adopted (and reflected) one of the main suggestions of *Houden van Hennen*: that there could be a more intricate connection between the form and function of husbandry systems for laying hens, and the corresponding product in the market. Although the egg trading company withdrew in the course of the project for internal business reasons, this close connection between production and marketing has remained a vital element of the project.

The consortium needed approximately three years to redesign the basic concept of the Roundel into a system that could actually be built at acceptable costs, through extended deliberative learning and reflection by the participants (for a much more elaborate analysis see: (Klerkx et al., 2010a, Klerkx et al., 2010b and Klerkx *et al.*, 2012), and funded by a special innovation programme (*TransForum*). For instance: a big hurdle turned out to be aligning the important marketing argument of hens that can roam freely in the open, and the above-mentioned reluctance within the sector regarding free range, because of health and safety risks. Finally, the Roundel concept was supplemented with outdoor access, but *quantitatively* less than what is required per hen for free range (2,5 m²) or organic (4 m²).

During this development a close dialogue was sought with the DB, which was preparing the aforementioned *Beter Leven Kenmerk* for animal friendly products. The hallmark awards one to three stars to products of animal origin that can be positively differentiated in terms of animal welfare. The highest degree –three stars– is awarded to organic systems or similar. This dialogue led to a public announcement in November 2008 at an agribusiness innovation symposium at which the director of the DB was granted the honour of symbolically drilling the first foundation pole for the first Roundel-inspired layer facility. He in turn awarded the Roundel concept two of the three stars of the *Beter Leven Kenmerk*. The first Roundel was opened in April 2010 by a representative of the Dutch Minister of Agriculture. On that occasion, DB granted the concept a third star, while a major Dutch retailer Albert Heijn announced that it would sell the eggs in its supermarkets⁴. While both actors' appreciation obviously contributed to the concept's legitimacy amongst particular constituency, the fact that *both* gave their blessings to one and the same concept may have had even more of a legitimising impact.

A third development was that the Dutch Minister of Agriculture took 'system innovation' as one of her main policy instruments (Verburg, 2008) in her future

⁴ More information can be found at <http://www.rondeel.org/>

vision of fully sustainable animal husbandry, mentioning the Roundel and Plantation concepts as exemplary cases. Of course, one could easily criticise the ambiguous and even sloppy use of the term 'system innovation' here and object that the design concepts cannot be said to be 'fully sustainable' and not breaking radically enough with existing patterns of food consumption and production. Nonetheless, the political acknowledgement that adaptations to current systems will not suffice in making a leap towards sustainability can be seen as a significant effect of these projects and designs on the regime level.

6.2. Interpretation: Heterogeneous consortium

Three features of designs can be shown to facilitate alignment between work on the niche level and on the regime level. Firstly, and obviously, the designs did lead to pilots that could be considered as innovation niche experiments with a strong commitment to developing into a market niche. Differently than for the Comfort Class prototyping, these pilots were initiated by private entrepreneurs rather than by a coalition of institutional regime players. The first pilot was driven by idealism and an explicit vision of animal welfare; the second primarily by a keen eye on (future) market opportunities. Key characteristics of the designs were important motivators in both cases: significantly improved animal welfare in combination with a differentiating visual form and market proposition.

A second feature is the explicit way the designs have shown how heterogeneous requirements - that often seem contradictory- can be integrated. The Roundel in particular has proved to elicit enthusiasm and initiative from farmers and animal protectionists, as well as a major egg packer, a system developer, and local and national authorities. This heterogeneity can at least partly be explained by the design approach that took the synthesis of the different actors' needs as a starting point.

Closely related to this, a third feature of the initial and rather unique consortium of two hitherto distant players in the supply chain in one of the pilots can be explained by this integrative approach as well. *Houden van Hennen* translated societal ideal images into features of the production process that ran parallel to requirements of the laying hen and the farmer. In the Roundel, important themes for specific citizen groups ('care', 'safety', 'privacy') were linked to functions in the system that are important for the farmer ('oversight', 'controllability') and for the laying hen ('room to escape', 'shelter', 'private laying nests'), as well as in the actual form (the round shape, the sheltered scraping area). Thus, a new production system was intricately linked to a market opportunity, and a new coalition of important players was the (unforeseen) result. Although the egg trader withdrew, the link between market and production system remained and –ironically–grew even stronger because of this withdrawal. In fact, the presence of the egg-packer led to innovative options in which there was no need for an egg-packer (Klerkx et al., 2010a).

The integrative approach does have its drawbacks as well. With Comfort Class, we saw how an explicit focus on animal needs in design has resulted in the establishment of a useful standard reference for ‘good animal welfare’, both within the branch itself and in its institutional environment. This is also expressed in the name of the design: ‘Comfort Class’ expresses a level or norm, whereas ‘Plantation’ or ‘Roundel’ do not. Although *Houden van Hennen* had analogous standards for animal welfare, this was only part of the message of the designs. The difference partly explains why the *Houden van Hennen* project elicited more response in the private sector than did Comfort Class, but had a less immediate effect on the institutional level. The more different issues are integrated into the design and into its message, the smaller the chances are that it will immediately appeal as an intermediate option to institutional players that, except for the government, mainly focus on single issues (like animal or farmers’ interests). This effect is seen even more profoundly in subsequent projects on dairy husbandry (Bos et al., 2009a; Bos et al., 2009b) and pig husbandry (Van Eijk et al., 2010a; Van Eijk et al., 2010b), that added environmental issues as well. Yet, in the end, in the case of the Roundel it seems that the breadth of the innovation (animal welfare, environment, market) ultimately made it especially attractive to a range of institutional supporting stakeholders.

7. RIO AND THE FUNCTIONS OF DESIGN

Our basic claim in this chapter is that design (as a process and a visual description of a possible material end result) may work as an intermediate option between the niche level and the regime level. It can do so by facilitating the interplay between, and alignment within, these levels, and thereby serve as an effective instrument for dual-track governance of sustainable transitions.

In Section 4 we identified seven meaningful functions for design as an instrument, which work either on the regime level alone or simultaneously on the niche level, and demonstrated these functions in the two cases described. This regards our first research question. Our second question was to what extent the design *process* contributes to eventual success or failure in niche formation and/or regime transformation. The designs in the cases might have been effective as well without any methodical foundation, by chance, by artistic genius, or by normal professional engineering abilities. Although we cannot fully refute these alternative explanations, we can at least pinpoint the relation between (aspects of) RIO and apparent and important mediating functions of the designs.

- **Redefinition of central concepts:** by operationalising animal welfare within the structured design approach of RIO, by positioning the animal as a user with needs that have to be met, both cases introduced an alternative discourse on animal welfare. This in turn opened up new possibilities for dialogue between farmers, animal protectionists, engineers and regime players, and for the setting of a common agenda.

▪ **Question basic assumptions and rules:** an essential characteristic of RIO is the bracketing of current standards, practices and solutions, and the abstraction of solutions to functions, thereby opening up the solution space. Especially in *Houden van Hennen*, this led to an –at least partial- refutation of the common belief that any improvement in animal welfare will by definition be detrimental to financial returns, or the assumption that round form factors are inefficient by definition.

▪ **Suggest possible niche experiments and inspire niche players to action:** in the *Houden van Hennen* case, the farmers who attempted to apply the designs in practice were mostly those who actively participated in one or more stages of the design process itself, for instance in creative workshops or design workshops. This pattern is corroborated by lessons learnt from recent applications of the method in projects with dairy cows (Cow Power, (Bos *et al.*, 2009a, Bos *et al.*, 2009b), pigs (Varkansen, (Van Eijk *et al.*, 2010)) and broilers (Broilers with Taste, (Janssen *et al.*, 2011)). The interactive character of RIO is an important factor in eliciting action by niche players. Of course, it is quite probable that these farmers would have taken an initiative anyway, but probably not with that level of ambition. The interactivity in RIO stimulates the mutual learning of professional experts and practising farmers, while its systematic and reflective character increases the probability that niche experiments will be radical leaps rather than adaptive steps. In addition, by promoting mutual vision formulation and collective learning by regime actors and practitioners at the same time, bottom-up initiatives that feed and fit these visions may increase their chances of being supported by regime actors, thus increasing their chances of becoming niche experiments themselves.

It can be concluded that the different steps in RIO stimulate second-order reflexivity by actors that become actively involved in the design process. In turn, this second-order reflexivity is a prerequisite for agency transcending the structuring force of the incumbent regime. In this way, applying design-oriented deliberative approaches like RIO may be seen as a form of knowledge production that transcends both the classical positivist and linear view of the generation of knowledge, and constructivist perspectives that perceive knowledge production as ‘extending the laboratory’ (Latour, 1987; Latour, 1983).

8. DESIGN, AGENCY AND LEGITIMISATION IN DUAL TRACK GOVERNANCE

The analytical focus on design in the preceding sections might obscure the important role of a range of actors that bring these interconnections about, and the role of power and landscape developments. Apparently, researchers played this intermediate role in both cases, not only in the first phase of design, but certainly also in the subsequent pilot phases. Yet a much more striking observation is of how, in both cases, actors with vested interests, engaged in practices shaped by the incumbent regime, embark on a learning process around

a design concept together with an non-governmental organisation whose *raison d'être* is to challenge that same regime. Thus, to a certain degree, regime actors themselves were actively engaged in intermediate work: on the one hand establishing a niche experiment, and on the other hand, and at the same time, re-evaluating important structuring assumptions (like the concept of animal welfare, or the importance of cost price)⁵. It was this heterogeneity of the actors involved and the fact that their viewpoints and concerns were (deliberatively) integrated in the designs, which lent the concepts legitimacy.

While design is a very real attractor and design processes are a good vehicle for these learning processes, they would not have come about without pressure and legitimisation from outside. Both cases were heavily influenced by a number of outside developments, including:

- The cultural and political landscape in the Netherlands at the beginning of the new millennium, which was increasingly characterised by criticism of livestock production and especially of the status of animal welfare, and which consequently put pressure on the incumbent regime and established practices;
- A continuing neoliberal perspective on the role of government and, consequently, substantial governmental resources that were diverted to research and animal-friendly initiatives by private actors (instead of enforcing legislation, for instance);
- Efforts and pressure by the Dutch government to align a multitude of actors to its future vision on integrally sustainable food production (e.g. the Covenant and the Implementation Agenda Sustainable Livestock Systems - *Uitvoeringsagenda Duurzame Veehouderij*).
- The rapidly increasing authority of the *Dierenbescherming* to grant their *Beter Leven Kenmerk* to animal products.

Thus, the experiments described in the case were enabled by outside pressures and subtly mobilised by them, and were legitimised by more all-encompassing political and cultural trends. At the same time, as we have shown, the design concepts themselves contributed to the formulation of a governmental vision of the need for system innovation. Years later, their actual materialisation in pilot experiments and new systems play important roles in aligning old and new actors (like the retail sector) to this governmental agenda. Their visual and material character should therefore not be underplayed in the establishment of linkages between the two tracks of governance.

⁵ It should be noted that there are also important differences between these cases in this respect. In the case of Comfort Class, the pilot project was deliberately 'contained' on an experimental facility of Wageningen UR, instead of a real farm, in order to mitigate the risk that the farmers' organisation would lose its members' support by turning too fast away from the majority of farmers. By contrast, in the case of *Houden van Hennen*, it was a farmer and a private enterprise that took the lead.

9. CONCLUSION

System innovation requires a transformation at the level of practice and at the level of the socio-technological regime that structures people's actions in daily life. Although SNM literature originally presumed that it was primarily the interplay of niche experiments that would result in changes at the regime level, under the influence of developments at the landscape level awareness is growing in transition studies that this unidirectional perspective is too simplistic. Niches and regimes do interact in a much more multi-faceted way (see for instance Smith (2007)), and a more strategic approach to interlink the two tracks of system innovation governance is needed. From the results presented here, we draw three main conclusions.

▪ **Design may acquire legitimacy across agency and structure**, thereby strengthening the linkages between the two tracks of governance. The cases make apparent the fact that regime players in the animal production sector themselves increasingly express second-order reflexivity and become conscious of the fact that their ambitions for sustainability do have implications for the way they choose their (structuring) actions. In this chapter, one issue appeared particularly essential: legitimacy in the eyes of both established players and those interested in sustainable innovations. In fact, the designs derived much of their legitimacy from the fact that they reflected diverse interests. Nobody could claim that the designs reflected one single particular value bias. When even stronger, they manifestly reconcile interests that had hitherto seemed un-bridgeable, thereby solving a strong tension in the face of strong, undeniable signals that inaction was no longer a viable strategy.

▪ **Design as a process and design as a visual representation of a possible end result mediates between niche and regime.** Both cases show how they may inform and inspire appropriate niche experiments. They also provide a shared framework for multiple niche experiments for identification and mutual learning, while at the same time being instrumental in the alignment of institutional action, agenda setting and problem redefinition.

▪ **Design may precede and facilitate the generation of a more common agenda on the strategic level.** At least in the sector of animal husbandry, this might be a route with more chance of success, given the relatively large number of independent entrepreneurs that cannot possibly be involved in a process of shared agenda setting.

Support for a radical approach by one or more regime players is a prerequisite. The design strategy applied here runs the risk of being pushed back within the incumbent regime, since the approach is essentially deliberative and interactive. However, the cases show how this risk can be mitigated if a more radical approach by the project team is explicitly legitimised and supported by one or

more regime players, including the financiers. In the case of Comfort Class, this role was taken by the DB with support of the Ministry of Agriculture, in the case of *Houden van Hennen* it was provided primarily by the latter. Still, an independent, consciously and reflexively chosen role of researchers is essential.

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Chapter 8. Co-design as an emerging distributed dialogical process between users and designers

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Abstract

In this paper we propose the following four key assumptions, illustrated with three examples, to analyse, organise and monitor design processes involving users: 1) users redesign the designers' technology by using it; the coupling of the technology with the users' new activity is thus at the core of the process; 2) design is a process distributed among various people whose interdependence has to be taken into account during the process; 3) developing both the technology and the activities implies various levels of dialogue that we define, drawing on Bakhtin's work; 4) focusing on one of these levels, we argue that it is crucial to highlight the various actors' differing perspectives during the design process.

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1. INTRODUCTION

To meet the challenges of sustainable development in agriculture, Meynard et al. (2006) argue the need to redesign farming systems through *innovative design*, i.e. design that produces new technical specifications as well as new knowledge – rather than using available knowledge. We share this point of view, but believe that this technical dimension should be tackled in close connection with the 'political' dimension, as both dimensions contribute to identifying a desirable future as discussed by Godard and Hubert (2002). In fact, there is no established consensus as to what a desirable future actually is: each actor can interpret sustainability according to his/her own values and different actors may value different goals and envisage different ways of meeting them. This political dimension is seldom taken into account by designers or in the methods they use in the design process.

Groot, Kerkamp and Bos (2008) have developed the Reflexive Interactive Design Approach, which constitutes the most promising attempt to address the issue so far. Their design method puts emphasis on involving various stakeholders in building the specifications of a new technology, e.g. during the very early cycles of the design process. We argue here however that the political dimension is at work throughout the design process, i.e. until the new technology has been implemented in work situations. We support this with a study of the way designers and future users can interact to co-develop a technology and its use. We use the term co-design to denote a process in which: (i) technical dimensions, on the one hand, and knowledge, practices and values, on the other, evolve jointly; and (ii) a desirable future is collectively discussed in order to define and implement acceptable solutions. More precisely, we present four theoretical assumptions, which can be used to anchor the monitoring and the analysis of co-design processes. It is beyond the scope of this chapter to discuss whether these assumptions fully define the requirements for achieving co-design in a relevant way. They are simply an attempt to reflect on what we have learnt from the different case studies in which we were involved as co-designers. Although the cases did not directly address the issue of sustainable development in agriculture, the assumptions that we built from these cases address certain social, political and technical dimensions of design processes. We suggest that they may therefore be useful to implement and analyse design processes dealing with sustainable objectives, which require the intertwining of technical and political dimensions. In doing so, we hope to participate in debate on design in both the farming system research community and the design studies community.

Some authors have already pointed out the need to foster cross-learning amongst designers and users in order to allow for the joint development of a technology, of a desirable future, and of the activity or the collective action in which the technology will be used. Most of them have discussed it from the perspective of user involvement. We can roughly distinguish three trends.

Von Hippel's work on lead users (see for example Von Hippel, 1986) is fairly representative of the first trend. The main focus is on firms' competitiveness. Enrolling lead users is viewed as a win-win partnership: on the one hand, the firm that launches a new technology can anticipate some difficulties which might arise at the time of its marketing; on the other hand, the lead user firms can secure a competitive advantage through rapid access to the new technology and a potential transfer of skills from the partner. Recent work by Von Hippel, notably based on Open Source software development, also points out that users' involvement in the design of this software is a form of democratic political engagement (von Hippel, 2005).

The second trend is reflected in user- and use-centred design methodologies. These were devised to develop a more effective technological design process while acknowledging the fact that use and users are always crystallised in a given technology. Their aim is to take on board use and user issues so that the technology will fit the requirements set for it (for more details see for example <http://www.upassoc.org>). In this approach, users document the design process, without necessarily being actors in it (Carroll, 1996).

The third trend is known as participatory design (see Kensing and Blomberg, 1998, for example). Participatory Design (PD) takes into account a number of political issues as its proponents recognise that technologies can have strong impacts on workers, and therefore claim that workers can legitimately contribute to the design process.

Our own perspective is close to PD, but we argue that there is a need to take users' inventiveness into account before crystallising certain uses and users' representations within the technology.

- We address this issue by focusing on the coupling that occurs between the technology and the user (Assumption 1).
- We also recognise that design is a distributed and interdependent process, as many authors do, but we suggest that such interdependence is not only at play at the technological level and needs to be tackled on a more political level, e.g. by examining the desirable future to which the design could contribute (Assumption 2).
- We then suggest, based on the work undertaken in three design projects (see Table 1), that the social, political and technological dimensions can be addressed by identifying three levels of dialogue (internal, external and macro-dialogue), drawing on the work of Bakhtin (1993) (Assumption 3).
- For us, dialogue takes place not only in a discursive way but also through prototypes, mock-ups, drawings and other artefacts around which interactions between designers and users should be organised. Even if these three levels cannot be considered separately when monitoring the design process, we suggest that there is a need to develop tools and approaches, which support the macro-dialogue level (Assumption 4).

In the following sections, we present these four assumptions and their theoretical underpinnings, and use the results observed in our three case studies to illustrate some of the issues considered here.

Table 1. Three case studies in which we were involved and which we use to illustrate our four assumptions

1. DIAGVAR software (Prost, 2008)

This software is dedicated to helping seed breeders, agricultural advisers and people in charge of the national registration of new cultivars, to assess new cultivars of soft wheat. The new cultivars are currently assessed in numerous cultivar trials and their assessors acknowledge that they do not take into account all the information produced in their networks of cultivar trials. Whereas they have data to characterise the cultivars in detail, they lack certain tools to process these data. DIAGVAR combines agronomic and statistical methods (Lecomte, 2005) to further analyse the data collected on the trial networks. It first characterises the limiting factors that affected the yield of the cultivars, by means of the indicators used in the trials. It can diagnose not only the effect of pest issues and the lack of nitrogen supplies but also such climatic factors as frost, heat, water shortages or lack of incident radiation in periods of development. None of these factors are easily or usually observable by the assessors. DIAGVAR then ranks the new cultivars tested in the trials according to their resistance to these limiting factors.

2. A safety system (an alarm) to avoid chemical runaway (Béguin, 2003)

The project was launched following many inquiries conducted in chemical plants where workers had been killed due to explosions caused by a "chemical runaway". In each case, workers who were on-site at the time of the chemical runaway all realised that something was wrong before the explosion, but they did not attempt to leave the premises until a few seconds before it occurred. There are several reasons for this, including the workers' wish to "recover" production and prevent the installation's destruction. But the main problem was the difficulty in assessing the time available before the explosion. The engineers therefore decided to develop an alarm which could help the workers to anticipate the critical moment, i.e. the explosion.

3. An alarm system to avoid systematic spraying against Sclerotinia in winter oil-seed rape (Cerf and Taverne 2008)

Sclerotinia is a fungus that can induce severe yield losses. In most French regions this occurs on average only twice every ten years, yet most farmers spray systematically against the fungus. This practice induces resistance in Sclerotinia stems to the current pesticide. Agronomists consider that avoiding unnecessary spraying is critical. The alarm system is based on various diagnostic tools (a grid to assess the level of infestation at plot level, a diagnostic kit to assess the level of plant contamination, and models which draw the contamination curve on a small regional scale). These tools can be combined in order to decide whether using pesticides is worthwhile. Decision making is based on thresholds which include economic, technical and environmental criteria.

2. FOUR ASSUMPTIONS TO DRIVE AND ANALYSE CO-DESIGN PROCESSES

As Dorst (2008) argues, "designers do not just design". For designers, designing is also defining "the environment they work in, their approaches to design situations, the role they take in design projects, the coalitions they work with, the way they deal with stakeholders". Accordingly, we consider that it is relevant, for

the design community, to shed some light on the theoretical assumptions that may underlie the way designers drive a co-design process, and not only on the methods used to make them operational during such a process. Moreover, these theoretical assumptions constitute a framework, which can be applied to analyse the design process.

2.1. Assumption 1: Focusing on the coupling of users with the technology

Whereas design methods are frequently based on an assumption that the main goal of design is to develop a steady technology before implementing it, many authors have shown users' inventiveness when using new technologies (see Bannon 1991; Greenbaum and Kyng 1991; Henderson 1991). Users tend to take over the technology creatively, *"reinventing devices through innovative applications"* (Feenberg, 1999). For example, users altered the French Minitel system and the Internet *"through a posteriori interventions adding human communication functions to systems that were originally destined to handle data"* (Feenberg, 1999). Feenberg has a political view of this appropriation, studying it in terms of "technical democracy". This political view is not our focus here but we think that the process of appropriation during the design process should not be overlooked. How can it be taken into account?

From the appropriation of a new technology to instrumental genesis

One first needs to recognise that, when it comes to a new technology, users do not act exactly as the designers had planned. Through a learning process, they seek to make the most of the technology and to enrol it, in order to increase their capacity for acting in their environment, based on their own understanding and needs. Rabardel and Béguin (2005) have called this process an *"instrumental genesis"*. The design of the chemical safety system is a fine example of that type of process. A prototype of the device was introduced and used on a pilot site for 8 months. The prototype (i) displayed the remaining time before an explosion, and (ii) provided highly precise information on the temperature of the product (within a hundredth of a degree). When the prototype was introduced on the site, operators used it not as an alarm, but as a precision thermometer to monitor the process. This "instrumental genesis"² is linked to the workers' operating strategy: they operate the process by maintaining it at the lowest possible temperature threshold, thus keeping the "reaction over speed" at bay. But such a strategy has its own risk: if the product cools down too much, it "crystallises" and

² With instrumental genesis we acknowledge the fact that users add functionalities to the technology designed, develop schemes for using the technology, which were not anticipated by the designers, or modify the technology so that it fits with their current way of using artefacts to act and achieve their goals.

becomes solid. This *overcooling* is a serious incident although quite different from the "chemical runaway". The alarm was very useful for keeping overcooling under control: the information on temperatures provided by the artefact was much more accurate than that provided by the other thermometers available on the site.

The second requirement is to recognise that, in this instrumental approach, the core of the design work is the design of an 'instrument', a mixed entity in which the technology and the way it is used purposely by a user are intertwined. The main idea is that a technology itself is not an instrument. It is the user who grants it the status of a means for his/her action. It thus accounts for the process by which individuals, who are ultimately users, continue design in use according to a learning curve. That differs from the traditional engineering approach to design, which defines it as a change of state during which a problem must be solved. To revert to the example of the chemical safety system, use of the alarm as a precise thermometer to handle overcooling was directly linked to the operators' action. This led us to explore how such an instrument would help to avoid chemical runaways while recognising and exploiting the efficiency with which the operators managed the process.

Consequences for managing a design process

A practical consequence for the design process is that it should simultaneously articulate the specification of a technology by the designers with the inventiveness of the users, as revealed through its implementation. Note that such coupling can be problematic. In the case of the *Sclerotinia* alarm system, the users were reluctant to explore how to use the system as they lacked confidence in its predictive capacity and had no curative techniques to limit the infestation by *Sclerotinia* if the indicator gave an erroneous recommendation (low infestation when in fact it became high over time). Other factors also dissuaded them from using the system, such as their understanding of the risk: they took into account not the frequency of attacks, as the designers did, but rather the potential severity of yield losses. Additionally, other practical issues slowed down the use of the system, such as the lack of sufficient specimens of the prototype to distribute it to farmers and advisers. The coupling between designers' technology specifications and users' inventiveness might also be seen as anchoring the design process in an incremental pathway rather than enabling more exploration. We argue that this really depends on the status given to the prototype. From our perspective (see Assumption 3), the prototype is meant to carry on the exploration rather than just testing how it could be implemented within work situations.

Irrespective of the difficulties involved, we nevertheless assume that the co-designers should ground the monitoring of the design process in the coupling of the technology with its use. This theoretical assumption has two implications. First, as noted above, it means that the designers must consider the technology they design as an assumption and not as a fixed result. In each of our three cases,

the prototypes were developed (criticised, modified, even rejected) with users in relation to their way of exploring their use. Second, focusing on the design of the instrument rather than on that of the technology raises the following question: how can the coupling of technology and use be sustained in the design process? Answers vary among the projects and this point needs to be adapted to each design environment. As an example, the designers of DIAGVAR asked some users to simulate the use of the prototype based on scenarios. These scenarios were built according to what was known of the activity of the professionals who assess cultivars and the problems they face while doing so, as highlighted by a first diagnosis of their activity (Lecomte et al., 2010). For example, people acknowledged their need to optimise their trial networks in order to reduce the cost of assessment. We proposed that they run DIAGVAR software on their own recent databases, on which they had robust expertise, so that they could see how it could help them with that issue.

2.2. Second assumption: focusing on a distributed yet interdependent design process

It is well known that design is an interdisciplinary activity, which typically involves people of different professional orientations working in teams (see Bucciarelli, 1994; Terssac and Friedberg, 1996). Two principles underlie this collective dimension: *distribution* and *interdependence*.

The distribution principle stems from the complexity of the design process. Regardless of the object being designed (a factory, a vehicle or a farming system), it is too complex for a single person to be able to represent all of its inherent problems and to possess all the abilities to solve them. The distribution principle assumes that this complexity is distributed among the members of a working team. The second principle is interdependence: specialists must articulate their different contributions. Interdependence appears directly in the technology being designed. Any modification or improvement made to one component of the technology may have an impact on the other components.

From our perspective, users can be seen as use experts who have developed their own knowledge, practices and values, which most probably differ from those of institutional designers. That is why their way of experiencing the coupling with the technology is unique. For example, the designers (i.e. agronomists) of the DIAGVAR software assumed that the simulations run by the cultivar assessors on their own databases would reveal their expertise, practices and values. In debriefing sessions which took place after these simulations, the users challenged the biological and statistical assumptions that the agronomists had embedded in the software to describe the genotypes and environmental interactions. For instance, the users made explicit their understanding of the growth and development processes of the cultivars in their own trials, as well as their appraisal of the variability of the cultivars' response to environmental

factors in their networks of trials. Their views differed from those of the agronomists, while highlighting some relevant discrepancies among users and designers. For instance, some potential users of DIAGVAR objected to the outputs of the software concerning the existence of one particular limiting factor in one specific cultivar trial. To take on board this problem, agronomists had to work on more accurate indicators for the given limiting factor and to test the sensitivity of the statistical methods used to identify that factor in a given trial.

Participants in a co-design process are also interdependent due to the various networks in which values, practices and new technologies concerning farming systems are discussed and stabilised. Special attention should therefore be paid to these networks so that the socio-political dimension can be addressed. The design process can be anchored in these networks but can also challenge them. This was the case in the DIAGVAR design process in which the first step was meant to identify such networks and to organise a workshop in which their strengths and drawbacks were pointed out (Prost et al., 2007). We therefore assume that interdependence must be taken into account in the building of a common desirable future and that it does not only impact the technology. Our approach is similar to that of Hutchins (1995), who states that the organisation of cognitive activity is more important than individual cognition to explain the achieved performance of a given activity. This is particularly true during design. Interdependence is not only at work at the level of technology; it also has to be considered at the level of the "desirable future" or of the learning processes. We expand on this idea in the following section.

2.3. Third assumption: focusing on design as a dialogical process

To consider the design process as a form of dialogue between heterogeneous actors, we need to specify the status of the technologies within that process. Indeed, from our perspective, even though language clearly plays a role that cannot be undermined, it is only one of the possible dialogical forms. We therefore assume that design may be a dialogical form based not only on language but also on more material dimensions, which can be recognised in a given technical medium.

Design as a dialogical form between actors.

Many authors have applied communication theories to analyse design. Day (1995) and Brown and Duguid (1994), for example, have proposed models in which designers try to design a "readable artefact" for the users. In relation to local development, Long (2004) has argued that, at the "*social interface*" between the different actors of a process of change, there are multiple discourses which serve to promote dominant political, cultural or moral standpoints. But few have really paid attention to technologies, even though they reflect designers' assumptions, and, as some authors point out (Erickson, 1995; Vinck, 2001),

mediate the interaction between the actors during the design process. We suggest that graphic representations, maps, scale models, prototypes and other artefacts convey the diverse assumptions made not only by designers but also by users, and show their disagreements or dilemmas. In that sense, they are points of articulation of the collective work as well as media for interactions.

Bakhtin (1993), who worked on dialogue to study the recognition of otherness, argues that dialogue takes place when the actions of one interlocutor, the listener, 'replicate' or 'respond' to proposals from the other one, the speaker. During dialogue, the listener needs to take into account the words of the speaker and to formulate a response that uses these words as potential resources. The 'response' is therefore two-sided: half-listener, half-speaker. But the speaker may impact on the thoughts and actions of his/her interlocutor at different levels. Bakhtin distinguishes three levels of dialogue: external, internal and macro. We will now explain how we propose to characterise these dialogical levels in a design process when we extend Bakhtin's proposal to media other than words and language, and will examine their consequences on design.

Three levels of dialogue enabling different learning processes among the participants

At the first level of external dialogue (the one most often called 'dialogue'), it is the object of the discussions that evolves. In design, it is the object of the design, e.g. the technology that evolves. We assumed that this first level of dialogue is the driving force for the development of the technology. The case of the safety system illustrates this point. We have already shown in this case (first assumption) how the workers assigned new functions to the result of the designers' work (the prototype of the alarm): they used it as an operating aid rather than as an alarm. This is a 'response' by the users to the designers' assumption. Such responses may validate or refute the designers' assumptions, but will often set in motion the design process. In our case study, the designers took this response on board to develop a second version of the artefact, to which they added a display of the historical record of the temperature changes. This made it possible to interpret the thermal kinetic 'trend' of the product, a strategic variable used by the operators in preventing crystallisation. Designers relied on the users' response to produce a second version of the prototype. In this example, the artefact developed through the dialogue that it supported.

For the second level, Bakhtin speaks of an "*internal dialogue*". This term conveys the idea that dialogical processes most often produce internal tensions or dilemmas for the person, which may open onto a development at the level of the actors' activity (Béguin, 2003; Engeström, 1987). So we assume that this second level of dialogue is a driving force for the development of the practices and values of each participant. For example, during the debriefing sessions (DIAGVAR case), each actor showed on a screen some software displays that s/he found difficult to interpret or did not agree with. The dialogue enabled the users to see

that their work organisation may have been the cause of some difficulties in collecting the data required to run the DIAGVAR software. It turned out that this difficulty existed prior to the assessment, even though it was exacerbated by the use of DIAGVAR. This prompted the users to think about how they could reorganise their work. Several propositions were made and implemented, which differed from one actor to another, according to the specificity of his/her situation. This entailed changes in several dimensions of the activity of assessment, such as the tools used to collect and analyse the data from the trials, the division of work among different people (those carrying out the trials, those collecting data on trials, those selecting the cultivars to assess, a.s.o.), and the skills needed to work on the data (recognition of the need for statistical skills). Designers may also be challenged by this internal dialogue. In the case of the *Sclerotinia* alarm system, the designers took on board the need for advisers to use the system at local level within a network of fields, whereas they had first imagined a direct use by the farmers at plot level. They then had to develop new methods to assess the relevance and robustness of the thresholds of infestation at this level, by developing their own design activity. This internal dialogue is a driving force for learning in participatory design, as many authors have shown (for example see Bjerknæs and Bratteteig, 1995). We assume that this level is critical to develop the participants' expertise, practices and values.

The last level suggested by Bakhtin is the '*macro*' dialogue. Bakhtin also called it the "*great dialogue*", because it is supra-individual and goes beyond the current 'external' dialogue. The main argument is that people take part in the dialogue with their ideas, with all that they have already built, said or done. We assume that this level includes notably what each one has constructed as a "desirable future" and that will need to be collectively re-built. It is a crucial level for taking on board the political dimension of the design process. Dialogue is then not only an inter-subjective process. Through the building of a desirable future, everyone takes part in a collective history, which is often implicitly conveyed during the dialogue and to which everyone contributes through external and internal dialogue. We discuss this macro-dialogue level more specifically in the next section.

2.4. Fourth assumption: driving the design process through the 'visibilisation' of the macro-dialogue

From our perspective, during a design process it should be assumed that the actors will not share the same knowledge, the same ways of acting or the same values (see Assumption 2). Therefore, dialogue contributes essentially to revealing contradictions, dilemmas or controversies that constitute a driving force of the design process. These dilemmas and controversies reveal concerns that have to be shared and taken into account by the actors during the design process. We assume that it is therefore crucial that participants acknowledge

their diverse stances and that they be given room to discuss them during the design process.

Through an anthropological analysis of design activities, Bucciarelli (1994) showed that engineers with different professional backgrounds have different ways of grasping or focusing on the same object: a "stop button emergency" for an automation engineer is a "junction box" for an electrical engineer. Although they are looking at the same object, each one grasps different properties of that object. What is significant and relevant for the one is without interest to the other. They have different professional perspectives grounded in what Béguin (2003, 2009) calls *professional worlds*. Each professional world is potentially a source of concerns, of purposes and of potential solutions.

How may visibilisation lead to learning?

We assume that design is a situation in which different experts, driven by their respective purposes and ways of thinking and acting professionally, contribute to the macro-dialogue, and that the macro dialogue is the process that reveals the diversity of professional worlds, as well as the need to articulate them. Obviously, designers and users do not share the same professional world³. Based on our experience, we think that many of the contradictions and dilemmas that emerge during the macro-dialogue between users and designers stem from the fact that they have different perspectives on the same situation or object. For example, the safety alarm was turned into an operating aid in the case of the chemical plant. However, the designers could not accept the idea that the users had assigned the function of an operating aid to the alarm. Such use violated a European norm, which stipulates that "monitoring systems" should be separate from "instrumented safety systems".

Furthermore, while the device enabled the operators to prevent crystallisation, the designers did not believe that the operators could run the process below a certain temperature without risking crystallisation. They had to admit this when they came to the factory and observed the operators at work. On the other hand, what role did the alarm play with regard to the runaway risk? A runaway simulation in real conditions enabled the operators to understand the use of the alarm, and to identify the need to change some procedures and their organisation in order to manage a runaway situation safely.

We use the term 'visibilisation' to denote the transformation of disagreements or dilemmas between the actors into a process of collective interpretation of matters of concern, in which the actors learn and make decisions accordingly. Rasmussen (2000) has already pointed out the key role of making controversies and dilemmas visible and collectively graspable in organisations. Nardi and

³ Most often, the dialogue between users and designers is defined as an exchange between scientific versus practical knowledge (Nassauer & Opdam, 2008). Even though scientific or practical knowledge is exchanged among the participants of the design process, our focus is not on knowledge as such, but on what the participants in the process decide to do with it.

Engeström (1999) have emphasised this role regarding work issues. In numerous situations, individuals and work are both invisible: they are dissolved into a set of indicators or procedures, whether formal or quantitative (Béguin, Owen and Waekers, 2009).

In the above example, the process of 'visibilisation' helped to reveal that designers and workers did not share the same perspective: they grasped and worked on different properties of the same situation. Indeed, the introduction of the alarm had put two perspectives "face to face". The first pertained to overcooling and to the risk of the product solidifying. The operators had developed their skills in this 'realm'. Their professional world was a "world of cold". As noted above, the alarm was very useful for keeping overcooling at bay. Thus, the users embedded the alarm in their own professional world. But the engineers had a different professional world, a "world of heat" – with reference to an explosion. The technology or, more exactly, the knowledge upon which it was based and that it embodied, was the outcome of *chemical runaway expertise*. Finally, 'visibilisation' allowed the group to objectify the fact that users and designers focused on different characteristics and properties of the chemical process: none of them were able to grasp all its properties on their own. But each of them recognised that all those properties were relevant and necessary to identify and solve different problems. Hence, the macro-dialogue reveals the range of problems that should be explored and solved during design.

How can visibilisation change the design orientation?

Macro-dialogue may also orientate the "desirable future" differently. In the case of the *Sclerotinia* alarm system, we point out the contradiction between the farmers, who appraised the risk of infestation by *Sclerotinia* on the basis of the severity of the yield losses it could induce, and the agronomists, who appraised it according to the frequency of a severe attack. While making this contradiction visible enabled the designers and users to better understand their respective stances on assessing the relevance of pesticide spraying, we also proposed a multi-criteria method to assess different pesticide strategies. The various actors (farmers, advisors, agronomists) then had a new resource to help them to interact and to start thinking differently about the need to reduce pesticide spraying: they envisaged connecting the alarm system to insurance services. In this case, the different worldviews merged to create an acceptable future: less use of pesticides, and fewer risks of economic failure, owing to the insurance system. This can be viewed as an essentially local and small move towards pesticide reduction. But one could also argue that such a proposal might apply to other pests as well, and therefore become a seed for a much broader change in the way of imagining services, which could result in a decrease of pesticide use.

3. CONCLUSION

As mentioned in the introduction, the cases on which we have built our assumptions do not directly deal with sustainable development. They have nonetheless helped us to build an analytical framework that we are able to use in our current and future work on the design of cropping and animal production systems. Two ideas emerging from this frame warrant special emphasis.

First, in this chapter, design is examined as an emerging process; in other words, the desirable future and what makes it possible to be achieved are not given from the outset, as soon as the design process begins. Even if an initial impetus/drive exists, as well as ideas for solutions, they will evolve throughout the process. This is explained not only by a possible lack of knowledge, as Midler (1995) argues, or by human beings' limited abilities in problem solving, as Simon (1973) maintained, but also by an intrinsic property of design processes, underlined by Schön (1983) in the famous metaphor of the "*reflexive conversation with the situation*". Design is an open-ended heuristic process in which the designer, striving to reach a goal, projects ideas and knowledge on a sketch or a graphic representation. But the situation replies and surprises the designer by presenting unexpected resistances. In focusing on the dialogical processes between actors, we argue that sketches or graphic representations or mock-ups and prototypes are a crucial means of obtaining surprising feedbacks, as argued by Schön (ibid.). Additionally, we assume that people taking part in the design process are themselves '*replying*' to the assumptions embedded in a prototype, a mock-up or a graphic representation, and then '*surprise*' the designers as well. This contributes to revealing the various matters of concern or problems that need to be solved and grasped collectively by designers and users through an innovative dialogical process. This type of approach to design differs from the one, which sees design process as a single step during which designers' knowledge and standards are applied in concrete situations. From our point of view, a design process is a place where the desirable future and the way to reach it are revealed, built, and discussed.

The second important idea, as we see it, concerns the different levels of dialogue. We insist namely on the fact that visibilisation, as an objectification of macro-dialogue, is crucial for sustainable development. We have argued that the different actors do not share the same knowledge, the same ways of acting and the same values. We assume that reality is always too big to be captured from one angle or one point of view. Through macro-dialogue, the design process reveals a range of issues and stakes to be dealt with to succeed in building a common project. We have also argued that this is done, in part, by organising the design process as a coupling of the users – in their own work activity – with the technology being designed. We think that such an objectification is part of the knowledge needed to identify solutions favourable to sustainable development and acceptable to the range of actors affected by the changes.

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PART III

Innovation with Promise

Chapter 9. Contending European Agendas for Agricultural Innovation

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Abstract

Amid expectations for a European ‘transition to sustainable agriculture’, there are competing transitional processes. Given the widely acknowledged harm from agro-industrial systems, unsustainable agriculture has divergent diagnoses and innovative solutions. In the EU policy context of a Knowledge-Based Bio-Economy (KBBE), there are also divergent accounts of its key terms: biological resources, economy, relevant knowledge and knowledge-producers. These accounts can be analysed as contending agendas for future agriculture.

The dominant agenda favours laboratory-based techno-scientific innovation as a means to use renewable resources more efficiently for competitive advantage in global value chains. Agriculture potentially becomes a factory for capital-intensive inputs to produce decomposable biomass for novel processes and industrial products. By contrast, a marginal agenda promotes farmers’ knowledge of natural resources, especially via agro-ecological methods, alongside agro-food-energy re-localisation. Through short supply chains that valorise a comprehensive identity for agro-food products, producers can gain more of the value that they add.

These agendas contend for influence over EU research priorities. Through their divergent agendas, stakeholders also promote different power relations: between farmers, the agro-input supply industry, research institutions, knowledge and markets.

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1. INTRODUCTION

Since the 1990s 'sustainable development' has become a mainstream slogan. As agro-industrial systems are put onto the defensive, their sustainability problems are diagnosed in ways favouring different pathways of agricultural innovation and techno-scientific knowledge. Originally the term 'sustainable agriculture' meant alternatives to intensive cultivation methods and farmer dependence on the agro-food industry. Since the 1990s the term has been appropriated for a future high-yield agriculture driven by agribusiness, especially through the Life Sciences.

As these divergent accounts contend for influence over policy and resources, 'sustainable agriculture' has become an ambiguous and contentious concept. Amid optimistic expectations for a European 'transition to sustainable agriculture', there are competing transitional processes. Each has its own agenda for ordering the future. Although one pathway may dominate, others will persist (van der Ploeg, 2008).

Given that the term 'sustainable agriculture' encompasses divergent meanings, why does it matter? The academic literature has various answers to this question. Some scholars regard the terminological ambiguity as a flaw that must be mended, e.g. through scientific rigour for a standard definition. Or they propose to reject the concept of sustainable development as inoperable. Others see its ambiguity as an inherent feature – and as an advantage for bringing together multiple parties to deal with the complex, socially contested issues surrounding sustainability (van Mierlo et al., 2010: 114).

Although that advantage may be realised in some circumstances, the terminological ambiguity generally helps dominant political-economic interests to promote techno-fixes for sustainable agriculture, while marginalising other approaches. Meanwhile policy frameworks use the term 'sustainable agriculture' as if its meaning were consensual, thus obscuring societal choices. European policy frameworks for 'multifunctional agriculture' generally accept the dominant account of capital-intensive innovation for economic competitiveness, while also marginally accommodating less competitive agricultures and/or public goods such as ecosystem services. This narrative can obscure societal choices, as if policy were simply pursuing external market forces.

To highlight such choices, this paper will explore the following questions:

- What are the main accounts of innovation for sustainable agriculture?
- How does each account diagnose unsustainability, propose solutions and favour specific R&D priorities?
- How does each account give different meanings to the same key terms? e.g. innovation, knowledge, natural resources, etc.

To explore those questions, the paper focuses on a case study: EU-level stakeholders' agendas for agricultural innovation and their efforts to influence research priorities. Although comprising only 5% of all European public-sector research funds, EU Framework Programmes have great importance: they set agendas which both express and influence wider research priorities. Although they are a special case, EU research priorities are particularly significant as symbolic and material investments in a future vision for society.

The paper draws on information from a European research project (see Acknowledgements). Sources include: stakeholder proposals, policy documents, research programmes and interviews with key actors (though none are quoted here).

2. AGRICULTURAL INNOVATION: ANALYTICAL FRAMEWORKS

Different accounts of sustainable agriculture have been illuminated by several analytical concepts, e.g. innovation as socio-technical systems, and innovation as divergent paradigms. These will be discussed in turn.

2.1. Socio-technical systems

As an analytical concept, socio-technical systems are meant to explain transitions from one system to another. A socio-cultural regime denotes various cognitive and normative rules as expressed in policy, science, users, markets, etc. Any regime provides niches for radical innovation – which can eventually change the regime. The socio-technical landscape denotes aspects of the wider political-economic environment, beyond the direct influence of niche and regime actors; changes here occur slowly, perhaps over decades. Together these three components – niche, regime, landscape– comprise the multi-level perspective. In key diagrams of this perspective, directional arrows move from niche to regime to landscape, whereby the components comprise a 'nested hierarchy' (Geels, 2004: 913; Geels and Schot, 2007: 401).

In response to criticism, the framework has been elaborated to emphasise societal struggles for influence over innovation choices: "When new technologies emerge, ... social groups have different problem definitions and interpretations, leading them to explore different solutions. This variety of meanings is eventually reduced through 'closure', an inter-group process of negotiations and coalition building..... In this socio-cognitive institutionalisation process, actors directly negotiate about rules (belief systems, interpretations, guiding principles, regulations, roles). This dynamic is played out at conferences, in journals, at workshops, struggles for research grants, etc. ... actors try to make sense, change perceptions as they go along, engage in power struggles, lobby for favourable regulations, and compete in markets" (Geels and Schot, 2007: 405).

In that process, a landscape may respond to a regime change and/or facilitate such change. "Socio-technical landscapes do not determine, but provide deep-structural 'gradients of force' that make some actions easier than others.... Landscape changes only exert pressure if they are perceived and acted upon by regime actors.... Societal pressure groups and social movements may voice protest and demand solutions. They can mobilise public opinion and lobby for tougher regulations. Outside professional scientists or engineers may have specialist knowledge that allows them to criticise technical details of regimes and propose alternative courses of action. Outsider firms, entrepreneurs or activists may develop alternative practices or technologies" (ibid: 403, 406).

How do different actors contend for influence over innovation agendas? Such an analysis may unduly stretch the regime concept within the analytical framework of socio-technical systems. So let us turn to the 'paradigm' concept, which has already been elaborated to analyse conflicts around agro-food systems. In general a paradigm is an explanatory model or problem diagnosis, which favours specific types of solutions.

2.2. Contending paradigms of sustainable agriculture

Since the 1970s agro-industrial systems have been put onto the defensive for causing various types of damage such as soil degradation, vulnerability to pests, greater dependence on agrochemicals, pollution, genetic erosion and uniformity, etc. Diverse remedies have been promoted in the name of sustainable agriculture. Originally this term referred to producers developing alternatives to crop monocultures, e.g. via less intensive and agro-ecological methods, as a basis for independence from the agricultural supply industry. Soon the term 'sustainable agriculture' was recast to mean a future high-yield productivist agriculture based on capital-intensive inputs. The Life Sciences propose remedies through 'sustainable intensification', thanks to genetically precise changes, which can protect crops from external threats.

Regardless of success in its own terms, this pathway conflicts with other European accounts of 'sustainable agriculture', which has been increasingly defined by distinct cultural values, linking the quality of food products, rural space and livelihoods with consumer support. Although chemical-intensive methods still prevail, the countryside has increasingly been regarded as an environmental issue, variously understood – e.g. as an aesthetic landscape, a wildlife habitat, local heritage, a stewardship role for farmers and their economic independence.

Towards those aims, farmers often develop modest innovations, e.g. substituting their knowledge for external inputs, thereby linking environmental with economic sustainability; but these innovations are often dismissed as inadequately novel or as elusive for government bureaucracies (SCAR FEG, 2007: 8; van der Ploeg, 2008). More fundamentally, research agendas have become more distant from producers' knowledge, while favouring specialist laboratory

knowledge for agricultural inputs and processing methods. According to an expert report, commissioned by the EU's Standing Committee on Agricultural Research (SCAR): "European agricultural research is currently not delivering the type of knowledge which is needed by end-users in rural communities as they embark on the transition to the rural knowledge-based bio-society. The problems are not exclusive to agricultural research but they are felt more acutely in this sector where the role of traditional, indigenous knowledge is already being undermined as a result of the growing disconnection with ongoing research activity" (SCAR FEG, 2007: 11).

What explains that gap between farmers' practices and agricultural research? According to the dominant agenda, farmers have failed to keep up with techno-scientific advances. Yet SCAR's 2nd foresight report diagnosed a long-standing problem: member states have been dismantling the institutional basis for disinterested science, public good training and extension services, thus undermining farmers' knowledge. As a remedy, the report advocated agro-ecological approaches, *in situ* genetic diversity, farmers' knowledge, etc., especially as means to enhance food security – by contrast to remedies based on lab science, e.g. ag-biotech. Actors promote different paradigms of problem-diagnoses and solutions (SCAR FEG, 2008). Divergent agendas use similar terms in their own distinctive ways. As climate change potentially destabilises agricultural systems, vulnerability becomes a threat to be addressed through various adaptive means. Resilience has emerged as a consensual concept for addressing such vulnerability: "Despite this consensus, different paradigms claim to have the solution to the challenges of the next and following decades. One yet-to-be-realised paradigm is focused on mobilising science and technology to increase resilience to shocks, reduction of dependence on external resources (and on fossil fuels in particular), open-source exchange of information and biological materials, and a strong involvement of farmers and other societal actors in co-researching the ways forward. Another, commercially dominant paradigm, relies on industry-led technological innovations, on markets, and on proprietary knowledge", (SCAR FEG, 2008: 56).

In the dominant account, resilience means 'the capacity of a system to experience shocks while retaining essentially the same functions and structures'. This definition understands vulnerability as occasional shocks, which warrant remedial or adaptive measures. By contrast, other accounts diagnose a systemic stress from agro-industrial monoculture systems (Jackson et al., 2010: 80). Such interpretive differences indicate contending paradigms of sustainable agriculture, as a potential basis to identify synergies and/or conflicts between them (SCAR FEG, 2008: 67).

Agricultural development pathways have been theorised as contending paradigms in several ways. Agricultural research agendas have favoured a biotechnological paradigm over an agro-ecological one, whose incremental farmer-led improvements are not officially seen as innovations. A combination of

factors has generally locked in biotech, while locking out agro-ecology, especially in public-sector research priorities. ‘The issue is thus how to break out of this lock-in situation, as incremental progress is just not enough...’ (Vanloqueren and Baret, 2009: 980). An analogous typology is Life Sciences versus Ecologically Integrated methods (Lang and Heasman, 2004). With a different focus on product quality, another binary typology is decomposability versus comprehensive product identity (Allaire and Wolf, 2004).

Contending accounts of sustainable agriculture can be analysed by combining those typologies. The dominant agenda combines Life Sciences and decomposability, while other agendas combine agro-ecology and comprehensive product identity (see Table 1 and also Levidow et al., 2012). Through these paradigms, stakeholder networks pursue their different agendas for the future. The next section examines the dominant account, while the subsequent one examines marginal accounts. The analysis focuses on arable agriculture and its links with energy production, especially in the EU policy context of the Knowledge-Based Bio-Economy (KBBE), although this concept also encompasses animal husbandry, forestry and aquaculture.

Table 1: Contending Paradigms of Agricultural Innovation

	Dominant	Marginal
Paradigms		
Techno-scientific engineering paradigm (paraphrasing Vanloqueren & Baret, 2009)	Genetic engineering and life sciences: modifying plants for greater productivity or for new objectives, e.g. nutritional content, via capital-intensive knowledge production.	Agro-ecological engineering: designing agricultural systems that minimise need for external inputs, instead relying on ecological interactions.
Quality in socio-technical paradigm (paraphrasing Allaire & Wolf, 2004)	Decomposability of qualities, via converging technologies, for recombination into profitable combinations for extra market value.	Integral/comprehensive product identity via holistic methods and quality characteristics recognisable by consumers, as a basis for their support.
Knowledge in socio-technical paradigm (paraphrasing Allaire & Wolf, 2004)	Computable data for novel inputs and/or outputs, which can gain market advantage, by correlating compositional qualities with product characteristics.	Knowledge for validating comprehensive product identities of various kinds, e.g. organic certification, agro-ecological production methods, territorial characteristics, specialty products, farmers’ markets, etc.

3. LIFE SCIENCES AND GLOBAL VALUE CHAINS AS THE DOMINANT KBBE

The Knowledge-Based Bio-Economy (KBBE) concept addresses the problem of unsustainable agriculture: conventional dependence on agrochemicals, as well as degradation and constraints of resources, alongside competing demands for land use. In the initial vision of the KBBE: “The EU’s ambition to build the world’s most competitive knowledge-based economy implies the existence of an efficient and effective knowledge-based bio-economy: a sustainable economy based on

renewable resources. This will help wean Europe off its dependence on diminishing oil supplies and will enable it to better compete with fossil-fuel rich areas of the world by levelling the energy playing field. It will also lead to the creation of new and innovative goods and services that will enhance Europe's competitiveness and meet the needs of its citizens", (DG Research, 2005a: 3).

3.1. Decomposable biomass for future value chains

In the Life Sciences account of the KBBE, narratives conflate the terms 'sustainable' and 'renewable': renewable resources will be used more efficiently and thus substitute for chemical ones. Moreover, beneficial characteristics are attributed to such substitutes: 'Eco-efficient products are less polluting and less resource-intensive in production, and allow a more effective management of biological resources' (DG Research, 2006). Sustainability is equated with greater efficiency, which can expand resource availability and enhance global economic competitiveness and thus European prosperity.

In the dominant account, these tasks are assigned to converging technologies. According to the DG Research Commissioner: "The life sciences and biotechnology are significant drivers of growth and competitiveness here. These sciences will help us to live in a healthier and more sustainable fashion by finding more environmentally friendly production methods and pushing forward the frontiers of science... This requires a holistic approach that transcends the narrow confines of scientific disciplines – blending, for example, the bio- and nano-sciences – and cuts across policy areas: from research and innovation, to trade and health and consumer affairs", (DG Research, 2005a: 1, 3)

In this Life Sciences perspective, eco-efficiency is sought through molecular-level changes in inputs, outputs and processing methods. In this decomposability paradigm, research seeks qualities that can be identified, standardised, quantified, extracted, decomposed, recomposed and commoditised in new forms (Allaire and Wolf, 2004). From this baseline, more specific knowledge can be privatised. Agriculture becomes a biomass factory; residues become waste biomass for industrial processes.

At the launch conference of the KBBE, a speaker drew analogies between current and future industrialisation: 'In addition to the countryside's role as a "food factory", it could be used to grow renewable bio-resources as sustainable raw materials for our energy needs and for industry' (DG Research, 2005a: 5). This frames the sustainability problem as an inefficiency to be overcome through a techno-knowledge fix (Birch et al., 2010). In this way, the KBBE narrative promises to link economic, environmental and social sustainability.

These research agendas have been co-developed with industry. In preparing FP7, the Commission invited industry to establish European Technology Platforms (ETPs), especially to define research agendas that would attract industry

investment. This arrangement has meant to meet the Lisbon agenda target of 3% GDP being spent on research. ETPs were meant to involve 'all relevant stakeholders' in developing a 'common vision' emphasising societal needs and benefits. This state-industry partnership has been much closer than a lobbying relationship.

For the agri-food-forestry-biotech-energy sectors, ETPs were initiated mainly by industry organisations, with support from scientist organisations. Several relevant ETPs were officially recognised by the European Commission and then granted start-up funds. In particular:

- Plants for Life, led by the EPOBIO network, representing ag-biotech companies and research institutes

- Forestry-Based Sector, 'Innovative and Sustainable Use of Forests', led by forest industries

- Food for Life, led by the CIAA, representing the European food industry

- Biofuels (and its predecessor, Biofrac), representing various industries and research institutes

- Sustainable Chemistry, hosted by EuropaBio, representing biotech companies

- Sustainable Farm Animal Reproduction & Breeding

(This paper focuses on how the 'biomass' concept links plants, fuels and chemicals; so the analysis here omits novel foods and animal breeding.)

In practice, membership in ETPs has defined who is (or is not) a relevant stakeholder; according to their prospective contribution to future value chains. Oriented to capital-intensive research and innovation, ETPs have little common ground with civil society organisations (CSOs), which have remained marginal. Citizens are relegated to the role of consumers, at best.

Early on, ETPs gained support from COPA, the European federation representing the relatively more industrialised farmers. As a high priority, COPA seeks ways to reduce input costs, while increasing productivity. But it played a only minor role in agenda-setting for R&D. Eventually COPA wondered whether the KBBE would offer farmers any benefit – other than selling biomass in competition with cheap imports.

3.2. Horizontal integration via recomposing qualities

In the dominant agenda, agri-production is recast as raw materials or biomass. Here the KBBE is 'the sustainable production and conversion of biomass into various food, health, fibre and industrial products and energy', according to a consortium of ETPs: " Through the improvement of plants, the Bioeconomy can produce healthier, high-quality, sufficient, diverse, affordable raw material for the sustainable production of food and feed', as an alternative to the fossil-based economy (Becoteps, 2011). Likewise a key challenge is 'sustainable feedstock production'; the post-2013 CAP must help 'to maintain a competitive supply of raw materials' (Clever Consult, 2010: 11). Efficiency benefits are attributed to

novel inputs: “In the coming decades, we anticipate the creation of more efficient plants (able to use water and fertiliser more efficiently and to be self-resistant to pests), leading to more efficient farms and new economic opportunities “, (Plants for the Future ETP, 2007: 5, 9).

As an industrial innovation, the agenda also promotes horizontal integration across sectors: food, feed, energy and other industrial products. Agriculture is seen as ‘oil wells of the 21st century’ (Biomat Net, 2006), i.e. like a mineral reserve for extracting renewable resources as biomass, which can be cracked into its various components for further processing. According to proponents, technological innovation provides new opportunities for rural employment but must horizontally integrate agriculture and energy as value chains: “However, the production of green energy will also face the exceptional challenge of global industrial restructuring in which the very different value chains of agricultural production and the bio-refining industries must be merged with the value chains of the energy providers”, (Plants for the Future ETP, 2007b: 33).

Playing a promissory role, the ‘value chains’ concept mobilises economic and political investment around prospects for future wealth. Biotech is promoted as a prime tool and beneficiary, and especially as a means to gain patents. These are cited as a key benchmark for Europe’s knowledge base and for its place in global competition. Patents are presumed to be a means to gain and protect income from new scientific knowledge, especially for biological resources, which are otherwise freely reproducible by farmers for re-use and exchange. For example, ‘Knowledge and intellectual property will be critical to fulfilling the goals outlined in the other four challenges’ (Plants for the Future ETP, 2007a: 9).

For diversifying the use of agricultural biomass, bio-refineries are already converting oilseeds or grain into fuels and feed. Some crops are being genetically modified specifically for commercially more valuable feed and/or for easier breakdown of cell walls. As a greater ambition, an ‘integrated diversified bio-refinery’ would also produce other industrial products. An analogy is drawn between plant material and crude oil: ‘New developments are ongoing for transforming the biomass into a liquid “biocrude”, which can be further refined, used for energy production or sent to a gasifier’ (Biofrac, 2006: 21). Such a metaphor naturalises the decomposability paradigm as the basis for horizontally integrating agriculture with energy production. Alongside these research agendas, the same organisations lobby for policy changes, which include: easier access to patents on biological material, more ambitious targets for biofuels, and public procurement criteria favouring ‘green’ products.

4. AGROECOLOGY & RELOCALISATION FOR A DIFFERENT KBBE

Although rarely using the term ‘innovation’, other agendas promote innovative agro-production methods, which help to bring producers closer to consumers. As an overall alternative for future European agriculture, shorter food supply chains

have been promoted as a means for producers to gain more from the value that they add, thus reinforcing agronomic practices which rely less upon external inputs. These chains build societal identification with food 'quality', variously defined and often rooted in a specific territorial origin and/or production method.

4.1. Quality as social identification

Institutional innovations are necessary so that producers, consumers and their networks identify with such forms of product quality. Agro-food identities depend upon various measures for promoting and validating quality, though not necessarily via formal certification. Going beyond territorial brands, food re-localisation builds identification and solidarity with local producers, e.g. in order to support environmentally less harmful methods and the local economy. Given the diverse bases for social identification, this has been theorised as a paradigm of comprehensive product identity (Allaire and Wolf, 2004).

In Brittany, for example, local food networks have developed innovative ways to supply consumers with food, often organic and/or higher-quality, while bringing them closer to producers. By selling their products through short chains, many farmers have found incentives to reduce their energy inputs – initially as a cost-saving measure and later as an environmental commitment. Already available, such methods could be implemented rapidly and at low cost; the main obstacles seem to be farmers' and institutional mindsets (Aubrée et al., 2010; Maréchal and Spanu, 2010).

Such an agenda has been promoted by numerous NGOs and the European *Coordination Via Campesina*. They have tended to elaborate on the 'food sovereignty' concept from the global South, rather than attempting to salvage the 'sustainable agriculture' concept from its dominant meanings: "The ways in which we grow, distribute, prepare and eat food should celebrate Europe's cultural diversity, providing sustenance equitably and sustainably... [e.g. via] the production and consumption of local, seasonal, high quality products reconnecting citizens with their food and food producers", (EPFS, 2009).

Cooperation among producers, as well as greater social proximity to consumers, has been promoted by practitioners' networks, whose motivations go beyond market advantage (Hinrichs, 2003; Renting et al., 2003). Such initiatives depend crucially upon support from local authorities, e.g. by facilitating cooperation, providing various skills for agro-food marketing, enhancing the public reputation of local and/or territorially branded food, and favouring local suppliers for public procurement. Often initiated by organic farmers, such networks can include and benefit different kinds of producers (Karner, 2010).

4.2. Agro-ecology as a different KBBE

Agro-food relocalisation has complemented agro-ecological methods, which emerged from the convergence of ecology and agronomy. Ecological science is applied to the study, design and management of agro-ecosystems. To develop agro-ecology as a new discipline, knowledge from separate disciplines has been collected and combined to solve problems at a higher scale – beyond a plot or farm. Although experimental, this larger scale has less control over conditions, and knowledge can less readily be generalised across contexts. Towards holistic solutions, agro-ecology needs interdisciplinary methods, including sociology and economics (Daalgaard et al., 2003). Indeed, agro-ecological knowledge production depends on closer social connections among farmers and various disciplines, especially on means to overcome barriers between them.

Agro-ecological methods do not correspond exactly to organic farming, for at least two reasons. On the one hand, these methods are used far beyond organic-certified farming, e.g. in economically less favoured areas, and so could be used much more widely than at present. On the other hand, some organic farmers have moved towards more industrial methods. These opposite tendencies have been conceptualised as the organification of conventional agriculture, alongside the conventionalisation of organic farming (Sautereau and Bellon, 2011).

By contrast to the dominant account of eco-efficiency, an agro-ecological account appropriates, enhances and/or integrates ecological processes. Organic farming attempts to keep cycles as short and as closed as possible, as a means to use biodiverse resources more efficiently. Such methods maximise the use of farmers' knowledge and locally available renewable resources, thus minimising dependence on external inputs, while also maximising outputs of diverse kinds. Residues can become media for recycling nutrients via ecological processes, so replenishing soil fertility.

This agenda has been conceptualized as Ecologically Integrated methods to enhance biodiversity, as means to improve productivity, nutritional quality and resource conservation (Lang and Heasman, 2004). These methods can complement shorter food chains: 'Agro-ecologists privilege alternative food systems operating at a regional scale or based on closer farmer-consumer relationships, or product networks that mobilize localized resources and have strong identities' (Vanloqueren and Baret, 2009: 981).

To promote those methods, the organics industry has helped to build a Technology Platform Organics, aiming to influence research priorities. Dissatisfied with agendas of officially recognised ETPs, the organisers put forward agro-ecological alternatives while also attempting to recast the KBBE concept. They proposed a Technology Platform for Sustainable Organic and High Welfare Food and Farming Systems. Such systems 'are an important and fast-growing part of the European knowledge-based bio-economy'. The proposal included 'industry objectives of improving (i) ecological and social sustainability, (ii) food quality and safety, (iii) production efficiency and profitability and (iv) introduction of innovation' (IFOAM-Europe, 2006). Like the Technology Platform

proposals from capital-intensive industries, this one was submitted to FP6 as a Coordination and Support Action, but it did not gain a sufficiently high score.

Even without funds from the European Commission, organics promoters continued the work. They built broad stakeholder support including relevant commercial actors across the agro-food value chain as well as environmental NGOs. Eventually they published a *Vision for an Organic Food and Farming Research Agenda to 2025* (Niggli et al., 2008), with the aim to set up a Technology Platform Organics. This has been followed by a *Strategic Research Agenda* in the name of TP Organics (Schmid et al., 2009). There the term 'innovation' is linked with public goods, farmers' knowledge, learning and competitive advantage. Key terms from the hegemonic agenda are recast to favour agro-ecology. For example: "... the innovations generated by the organic sector have played an important role in pushing agriculture and food production generally towards sustainability, quality and low risk technologies... Organic agriculture and food production are innovative learning fields for sustainability and are therefore of special interest to European societies.... In order to maintain a leading position in this innovative political and economic field, research activities are crucial", (Niggli et al, 2008: 9).

According to their problem-diagnosis, organic farming faces a problem of low productivity, which has potential solutions in agro-ecological engineering, here called 'eco-functional intensification': "The weakness of organic agriculture so far remains its insufficient productivity and the stability of yields. This could be solved by means of appropriate 'eco-functional intensification', i.e. more efficient use of natural resources, improved nutrient recycling techniques and agro-ecological methods for enhancing diversity and the health of soils, crops and livestock", (Niggli et al, 2008: 34; cf. Schmid et al., 2009: 59).

Horizontal integration between agriculture and energy production provides means to close up organic cycles, as well as to substitute for external inputs: "Diversified land use can open up new possibilities for combining food production with biomass production and on-farm production of renewable energy from livestock manure, small biotopes, perennial crops and semi-natural non-cultivated areas. Semi-natural grasslands may be conserved and integrated in stockless farm operations by harvesting biomass for agro/bio-energy and recapturing nutrients from residual effluent for use as supplementary organic fertiliser on cultivated land", (Schmid et al., 2009: 26).

TP Organics has developed its research proposals in consultation with farmers, food processors and distributors, partly through Europe-wide consultation meetings. The concept 'eco-functional intensification' refers to the search for ways to increase productivity without conventionalising organic farming. This concept has aroused keen interest in the organics section of COPA, as a basis to support 'a European knowledge sharing and transfer platform for organic and low-external input farming'. The consultations strengthened specific proposals, as a stronger basis to influence research priorities.

5. SHAPING EU-LEVEL RESEARCH PRIORITIES

Stakeholder proposals for agricultural research have sought to influence state agendas, especially the Framework Programme 7 on Food, Agriculture, Fisheries and Biotechnology (FAFB), which runs between 2007-13. From the start, it has aimed at 'building a Knowledge-Based Bio-Economy'. Here the KBBE is understood as 'the sustainable, eco-efficient transformation of renewable biological resources into health, food, energy and other industrial products' (DG Research, 2006). The FAFB programme has tensions between different agendas and their accounts of a KBBE.

When FP7 began, approximately half the calls were drawn from proposals by officially recognised ETPs, led by capital-intensive industry. The food, crops and forestry ETPs were among those whose proposals had the greatest coverage in FP7 priorities (DG Research, 2007: vii). As a route to this successful influence, the Commission referred to ETPs as if they were neutral experts in both technological and commercial prospects.

From the start, the programme emphasised Life Sciences and converging technologies, especially as a means to identify biological characteristics, which could enhance value chains in future markets. The FAFB programme has had an average annual budget of €200m, allocating approximately one-quarter to Activity 2.3, 'Life sciences, biotechnology and biochemistry for sustainable non-food products and processes'. As that title indicates, earlier priorities were largely shifted to non-food uses, including energy and other industrial products.

The adjective 'green' means the substitution of plants as raw materials. For example, the call for research on 'Green Oils' aims to develop 'Market driven, hardy, viable and profitable oil seed crops with enhanced traits derived from conventional and biotechnological breeding techniques which exploit the post genomic knowledge base' (DG Research, 2006: 45). Here green or natural can mean any product of biological processes.

Funders expect economic and environmental benefits from techniques, which standardise novel data. These agendas are naturalised through anthropomorphic metaphors of nature, e.g.: metabolic engineering will enhance knowledge for 'green factories' to provide efficient engineering of high-yield and quality products; research will expand the biochemical diversity of natural product libraries; biocatalytic processes will provide high efficiency and low environmental impacts; modern biotechnology will provide systemics for cataloguing and therefore preserving microbial diversity, etc. (DG Research, 2008). These R&D priorities coincide closely with the Strategic Research Agendas and narratives of ETPs (e.g. SusChems, 2005; Plants for the Future, 2007).

In response to the calls, specific research proposals are evaluated for their prospective Impact, which counts as 1/3 the evaluation score. Commercial prospects are a strong criterion, especially for research towards novel plants; the expected Impact often includes the term 'market-driven', potentially meaning patents. Research agendas emphasise 'pre-competitive' research – understood as

generic knowledge which itself does not provide commercial products but which can lead to them. As this concept recognises, commercial techniques and products depend upon freely available knowledge for common standards (Allaire and Woolf, 2004). At the same time, 'pre-competitive' research anticipates competitive innovation within the decomposability paradigm, eventually generating patentable knowledge.

Along with the FAFB programme, the FP7 Energy programme launched a joint initiative for research on 'Sustainable Bio-refineries' in 2008. This likewise responded to ETPs' proposals for horizontally integrating agriculture with other industrial products by redesigning and recomposing biomass. Several calls were put out for proposals related to novel crops and processing methods for converting biomass more efficiently into liquid fuels. By mid-2009 the Commission had approved biofuel projects totalling €60m.

Despite the dominant agenda, the FAFB programme has included some other research priorities. Some promote knowledge for protecting public goods in an agricultural context. While organic methods always have had a presence in EU Framework Programmes, FP7 has given greater prominence to agro-ecological themes, whose calls had reached a total budget of 20m Euros by 2010 and increased thereafter. Agro-ecology is seen as a means to solve problems of resource shortages and pollution, as well as to provide public goods such as ecosystem services. Although the term 'agro-ecology' does not appear in FP7 documents, the FAFB programme included several agro-ecological themes: enhancing soil management, recycling organic waste, replacing chemical pesticides, developing integrated pest management, enhancing on-farm production of renewable energy, etc. (DG Research, 2008, 2010).

Such priorities have played a stronger role since the start of FP7, partly by incorporating proposals from TP Organics. Its novel concept, 'eco-functional intensification', has attracted interest from DG Research. This opportunity has had several sources in wider deliberative processes.

The FAFB programme has hosted foresight exercises, aiming to open up research agendas to wider knowledges (see Section 1.2 above). Its second report advocated new kinds of Agricultural Knowledge Systems (AKS) beyond the formal research system. It emphasised innovations resonating with proposals from TP Organics: "Farmers cannot be supported by AKS to follow new innovation paths supportive of public good goals if there is not a clear support from public agencies. The AKSs that have been developed outside the mainstream, to support organic, fair trade, and agro-ecological systems, are identified... as meriting greatly increased public and private investment. These documents also argue for bringing the lessons of existing sustainable, productive, profitable agro-ecological [systems] into the AKSs mainstream. AKSs for instance would focus on ways to reduce the length of food chains, encourage local and regional markets, give more scope for development and marketing of seeds of indigenous crop varieties and foodstuffs, and restore the diversity of within-field

genetic material, as well as of farming systems and landscape mosaics “, (SCAR FEG, 2008: 42).

Similar accounts of *in situ* agricultural diversity have gained prominence in discussions among national agencies that fund agricultural research. Having adopted ‘Green Growth’ as a conference theme, participants gave the concept a different meaning than the dominant productivist one: “We have to optimise sustainable growth dedicated to human welfare and the environment, e.g. nutritional value/hectare rather than volume/hectare; acknowledge diversity of situations and thus diversity of solutions; assess agricultural impacts within the global context and with regard to all interfaces.... We have to promote co-operation rather than competition with regard to research disciplines and research stakeholders... We have to increase our capacity to preserve public goods, share infrastructures and develop open access databases”, (Euragri, 2010).

In these ways, a rival account contends for influence in EU-level research agendas and other policy arenas.

6. CONCLUSIONS: CONTENDING AGENDAS OF AGRICULTURAL INNOVATION

Amid expectations for a European ‘transition to sustainable agriculture’, there are competing transitional processes. Given the widely acknowledged harm from agro-industrial systems, ‘unsustainable agriculture’ has divergent diagnoses and innovative solutions. This rivalry can be analysed as contending innovation agendas; the analysis here combines theoretical paradigms of agricultural innovation, as summarised in the Table 2.

These agendas are promoted by distinct stakeholder networks, especially via European Technology Platforms. In an EU policy context of a Knowledge-Based Bio-Economy (KBBE), there are divergent accounts of its key terms: biological resources, economy, relevant knowledge and knowledge-producers. Likewise, divergent accounts are found of innovation, intensification, resource efficiency, resilience, bio-energy, horizontal integration, etc. (Levidow, 2011).

The dominant agenda favours laboratory-based techno-scientific innovation as a source of ‘efficient’ inputs, which can use renewable resources more efficiently for competitive advantage in global value chains. Agriculture becomes a factory for recomposable biomass, as inputs for capital-intensive processes and various industrial products. This reduces farmers to input purchasers and biomass suppliers, while marginalising their own knowledge. Innovation becomes a search for the optimal lab-based technology (cf. Godin, 2006; Felt et al., 2007). At the EU level this agenda is led by a state-industry partnership, especially European Technology Platforms, representing multinational companies and large research institutes.

Table 2: Contending Agendas of Agricultural Innovation

Paradigm Issue	Life Sciences	Agro-ecology
Problem-diagnosis: agro-economic threats	Inefficiency (of farm inputs, processing methods and outputs) disadvantaging European agro-industry, which falls behind in global market competition for techno-scientific advance.	Agro-industrial monoculture systems – making farmers dependent on external inputs, undermining their knowledge, distancing consumers from agri-production knowledge, etc.
Solution in sustainable agriculture	More efficient plant-cell factories as biomass sources for diverse industrial products. As 'oil wells' of the future, agricultural biomass can be a substitute for fossil fuels, thus expanding available resources. Sustaining economic growth, resource usage and commodity flows.	Agro-ecological methods for maintaining and linking on-farm resources (plant genetic diversity and bio-control agents), thus minimising usage of external resources. Sustaining the resource base, communities and solidarity.
Society as community; social sustainability	Individual beneficiaries of global markets through rural employment and novel 'green' products available for rational consumer choice.	Closer producer-consumer links through trust in a comprehensive product identity based on images of quality, food culture and territory/place.
Natural resources	Mechanical-informatics properties as a natural cornucopia, which must be identified, unlocked, mined and commercialised in value chains.	Ecological processes (e.g. nutrient recycling, soil as a living system, whole-farm systems, etc.), which can be used by farmers for agricultural production.
Resource constraints	More efficiently use renewable resources, so that productivity increases overcome constraints and thus continue economic growth, i.e. commodity circulation in the global economy.	Re-link production and consumption patterns in ways reducing dependence upon external inputs, while enhancing diverse outputs, towards greater self-sufficiency.
Resilience against vulnerability	Capital-intensive defences against external shocks (e.g. climate change), so that the system can maintain, restore or even increase productivity.	Bio-diverse farming systems with lower dependence on external resources, thus avoiding endemic stresses of monoculture systems & climate change.
Knowledge	Computable data for more efficient, flexible agro-inputs, production methods and/or outputs, which can gain advantage in value chains. Laboratory research to create databases of standard information. Privatisable knowledge, verified by pre-competitive research and public reference standards.	Farmers' collective, experiential knowledge of natural resources, ecological processes and product quality, as a basis to minimise dependence on external inputs. Scientific research to explain why some agro-ecological practices are effective. Open-source exchange of information and biological materials (organicEprints)
Quality	Compositional qualities that can be standardised, identified, quantified, extracted, decomposed and recomposed for extra market value.	Comprehensive product qualities – e.g. aesthetic, production methods, farmers' skills, rural space – recognisable by consumers as a basis for their support.
Eco-efficiency as intensification: using renewable resources more efficiently	Sustainable intensification via smart inputs from lab knowledge: enhancing external inputs, engineering their compositional qualities and increasing land productivity.	Eco-functional intensification via farmers' knowledge of agro-ecological methods: improving nutrient recycling techniques, enhancing biodiversity and enhancing the health of soils, crops and livestock.

Knowledge-Based Bio-Economy (KBBE)	Sustainable production and conversion of biomass [or renewable raw materials] into various food, health, fibre, energy and other industrial products.	Agro-ecological processes, in mixed and integrated farming, for optimizing use of energy and nutrients, so that producers gain from the value that they add.
Agricultural Knowledge Systems (AKS)	Cooperation among actors in value chains, esp. for linking biological characteristics with novel inputs and products.	Cooperation between lab science, agronomy and farmers, especially for enhancing their knowledge of natural resources for sustainable production methods.
Product validation	Technological convergence for databases to standardise properties of molecular components and their new combinations.	Certification systems for product identity or integrity that will be recognised by consumers.
Economy & markets	Global value chains realising market value in commodities (agro-inputs and outputs) and proprietary knowledge, as a basis for capital-intensive knowledge to gain from added value.	Shorter agro-food chains, based on consumers' trust and greater proximity to producers, as a basis for valorising their knowledge of natural resources, cultivation methods and food culture.
Government policy on research food chain bio-energy externalities	Private-sector access to innovation-friendly policies, e.g. public funds for research, natural resources and proprietary rights over knowledge. Avoid unfair anti-competitive practices, which block more efficient supply chains. Subsidy and targets for bio-fuels to create a European market and thus stimulate innovation, which can be exported. Green public procurement rewarding processes which minimise externalities.	Farmer access to integrated agro-ecological research and to advisory (extension) systems. Support for food re-localisation via infrastructure and urban-rural linkages. Measures for farm-level development of bio-energy, which can substitute for (or supplement) external sources. Incentives for all actors along the value chain to internalize as many externalities as possible
Public knowledge and support	Need a European society in which all stakeholders understand and trust the concept of the bio-economy. Concerns about genetic information need to be addressed and overcome for the Bio-economy to achieve its potential.	Need a public, which is knowledgeable about agro-production improvements via agro-ecological methods and re-localising European economies.

Note on Table: Diverse accounts of sustainable agriculture can be analysed as contending paradigms. The Table draws on several typologies – Lang and Heasman (2004: 28-34), Allaire and Wolf (2004), Marsden et al. (2002), SCAR FEG (2008), SCAR FEG (2011) and Vanloqueren & Baret (2009).

By contrast, other agendas promote farmers' knowledge of natural resources, especially via agro-ecological methods. On this basis, they can reduce energy inputs, increase productivity and add value through quality. In this account of eco-efficiency, production methods appropriate, enhance and/or integrate ecological processes. Such methods also can enhance public goods (Schmid et al., 2008). Such benefits depend on joint knowledge-production, spanning the boundary between knowledge generators and users (EU SCAR, 2012: 32, 42). Through short supply chains that valorise a comprehensive identity for agro-food products, producers can gain more of the value that they add. These short

chains, also known as relocalisation, depend on combined knowledges from diverse sources. At EU level this agenda has been led by Technology Platform Organics with support from organic farmers' organisations, small businesses across the agro-food supply chain and environmental NGOs.

With those contending agendas, rival stakeholder networks seek to influence R&D priorities, especially the EU's Framework Programme 7 on Food, Agriculture, Fisheries and Biotechnology (FAFB). This programme aims to build a Knowledge-Based Bio-Economy (KBBE), a concept originating in European Commission policy for the Life Sciences. Accordingly, the FAFB programme has favoured lab and engineering knowledge for more 'efficient' products as a means to create a more sustainable agriculture. At the same time, the FAFB programme has increasingly promoted agro-ecological research, thus overcoming its general lock-out from research agendas. This resulted from coordinated efforts by stakeholder and expert networks attempting to influence R&D agendas.

From the standpoint of multifunctional agriculture, such contending agendas can play complementary roles in different rural spaces. Some agro-food practices may combine aspects of different paradigms. As a concept, Agricultural Knowledge Systems may provide a common space for interchanges between divergent agendas and their research priorities.

However, these innovation agendas promote conflicting visions of the future. Rival coalitions attempt to influence R&D priorities, innovation trajectories and wider policy frameworks along those divergent lines. In addition to simply competing for research funds, they promote different power relations between farmers, the agro-input supply industry, research institutions, knowledges and markets. They promote different accounts of social, environmental and economic sustainability – also known as people, planet and profit, respectively. Moreover, the Life Sciences agenda dominates agricultural research priorities, partly by appropriating key terms from other agendas. Capital-intensive innovations tend to gain commercial domination in agro-food markets, thus likewise marginalising other agendas (e.g. agro-ecology, short supply chains, etc.).

These contending agendas are generally treated as complementary in research programmes. By contrast, stakeholder conflicts arise overtly in several policy areas: agricultural subsidy (reform of the Common Agricultural Policy), ag-biotech regulation, patent rules, public procurement, land-use planning, etc. Stakeholder networks attempt to use or shift the wider political-economic landscape along lines favouring their account of sustainable agriculture and its emerging regimes (cf. Geels and Schot, 2007).

These societal choices can be obscured by policy frameworks, which favour 'efficient' techno-fixes from capital-intensive innovation. Social science faces an analytical task: to identify how stakeholder groups contend for influence, especially how they define and justify the societal challenges (or problems) that warrant agricultural research. On this basis, critical analysis can inform wider efforts to gain public accountability for societal choices, as well as for the research agendas that favour or marginalise those choices.

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Chapter 10. Understanding Eco-industrial Development Processes through Multiple Change Perspectives

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Abstract

Eco-industrial parks are receiving increasing attention in light of the sustainability discourse. Although the formation and development of eco-industrial parks have been investigated, these processes are difficult to grasp. In order to better understand and govern the trajectory of these processes, this chapter attempts to reveal some of their complexity. It addresses the formation of industrial parks from a change perspective, with a focus on the interplay between actors and context. We use two lenses to build a combination of change perspectives: transition management theories, and the episodic and continuous change concepts of organisational theory. Both of these lenses distinguish between change that is planned, abrupt and discontinuous, and change that is emergent, incremental and continuous. The main lesson of the paper is that actors' perspectives of change and development affect possible governance strategies. Planned change assumes that actors are unable to adapt their underlying structures to the new demands for sustainable development and thus require interventions from the outside. In the case of continuous change, actors are seen as self-organising. This process calls more for facilitation and removal of possible stumbling blocks. In order to choose a good governance strategy applied to the circumstances, these perspectives need to be combined.

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1. INTRODUCTION

The eco-industrial park concept comes from industrial ecology theory. This theory sees industry in analogy with natural ecology: *a web of connections between entities enables each entity to use the others' products and waste products* (Frosch, 1992). More concretely, an eco-industrial park is one where co-located firms, or in this chapter co-located intensive agricultural firms, engage in industrial symbiosis. Industrial symbiosis assumes that a group of geographically proximate individual firms enhances its collective economic and environmental sustainability by coordinating its resource management (Ashton 2008), e.g. by physically exchanging by-products, sharing in the management of utilities and sharing ancillary services (Chertow et al. 2008).

Although the idea of industrial symbiosis has been picked up by policy makers (Ehrenfeld and Gertler 1997; Gibbs 2003), and technical and economic opportunities exist, actual implementation of the concept is very difficult to achieve and the rate of failure is high. This chapter intends to improve understanding of the complexity of eco-industrial park development and the consequences for its governance. Rotmans and Loorbach (2009) and Hoffman (2003) have complained that industrial ecology science has a more technocratic approach to physical streams than to the social process of how to achieve them. However, scholars are increasingly concerned with the social facets of this phenomenon, and want to understand how the development of industrial ecology and industrial symbiosis can be stimulated. According to Ashton (2008), research in industrial symbiosis has much to gain by drawing on economic geography or on organisational theories.

There have already been important contributions in industrial symbiosis literature using these approaches, such as the differentiation between planned and emergent industrial symbiosis (Chertow, 2007). In planned industrial symbiosis, the government is involved in the identification and location of the relevant companies. In emergent or spontaneous industrial symbiosis, private actors' decisions are the basis of the industrial ecosystem (Chertow, 2007). For policy makers, this means that emergent industrial symbiosis needs support: the appropriate policy is usually to build on existing or emergent areas that have already passed a market test. Policy can strengthen them through post factum coordination, encouragement, and support in terms of logistics and through technical and financial assistance (Chertow, 2007). For planned projects, developers have to focus first on the characteristics they can control, and second on providing the preconditions (support) for more elusive aspects for eco-industrial parks to evolve. Policy makers should focus on arranging an environment where clusters can arise, rather than purely controlling the content of clustering processes (Deutz and Gibbs, 2008).

Many initiatives for eco-industrial parks are planned *de novo* (Deutz and Gibbs, 2008). However, the most successful examples of these parks have properties of the spontaneous, emergent type (Chertow, 2007; Chertow et al. 2008; Deutz and

Gibbs, 2008). In existing planned cases, other connections between companies precede collaboration on industrial ecology issues (Deutz and Gibbs (2008), as in the case of emergent projects. Baas and Boons (2004) state that the stimulation (not to mention planning) of industrial symbiotic developments is difficult because of its sensitivity to unique local factors, institutional contexts and exceptional events. Moreover, many of the present developments occur without or in spite of governmental support. Some form of steering is however necessary, as otherwise many possibilities for industrial symbiosis will remain unused.

Our chosen theoretical lenses, namely transition management theory and the concepts of episodic and continuous change (Weick and Quinn, 1999) from organisational theory, provide concepts to understand and govern change processes and have a perspective on planned and emergent change. Transition management has already been related to industrial ecology (Rotmans, 2009; Baas 2008; Adamines and Mouzakis, 2009; and de Vries and te Riele, 2006) and industrial symbiosis (Gibbs, 2009), and has a strong focus on process levels. But although this theory emphasises the importance of working with actors with different views, it does not enter into detail on how these views, opinions and beliefs are created by people, and how sharing or not sharing them can influence the process. For that reason, we will also use episodic change and continuous change (Weick and Quinn, 1999).

This chapter examines what the combination of these change perspectives can mean for the understanding and governance of the complexity of eco-industrial park development. We first discuss the insights of transition management theory and of the episodic and continuous change concepts, and then build combined change perspectives based on that discussion. A case study is used to illustrate the value of this combination. To conclude, we discuss its value for eco-industrial park development.

2. COMBINING CHANGE PERSPECTIVES

2.1. Transition management theory

The world consists of different evolving sub-systems, such as technology, economics or culture. Evolutions of these systems, although partly independent, can affect other systems irreversibly, generating new developments in these systems. This means that systems are in co-evolution (Kemp et al. 2007). For example, because of the oil crisis, cogeneration (technological system) in greenhouse horticulture (agricultural system) became economically interesting (economic system), leading to a massive scale increase in the sector (economic and agriculture system) and as such to a higher urgency for greenhouse parks, from both landscape (environmental system) and cost (though scale advantages) perspectives (economic system). When these kinds of changes are congruent through all the different systems at different levels, they generate radical change

(Rotmans, 2005). The punctuation of a long period of slow changes by a short period of radical changes is a transition (Kemp et al. 2007) and usually takes some decades (Geels, 2005).

Transition of the societal system can be a solution for persistent problems such as unsustainable production. Woven into the system (Rotmans, 2003), these problems do not seem to be caused by identifiable actors or factors (Dewulf et al. 2009). The solution is a change of the existing regime of rules and practices into something new. Transition management theory provides a frame to better understand this change process and gives a strategy to solve persistent problems (Rotmans 2003, Rotmans et al. 2009).

Transition management interacts on different levels, as explained by Kemp et al. (2007) and Rotmans and Loorbach (2009). After an integrated system analysis and actor selection, a transition arena is formed at the strategic level. In this arena, different stakeholders develop a shared vision under the direction of an independent transition manager. When there is a shared vision, milestones or steps towards the vision will be fixed, going back and forth between the current situation and the vision of the desired future (back-casting). Different transition pathways towards the vision can thus be designed. Although both pathway and vision can change during the process, the direction remains the same. The transition pathways are a bridge between the strategic level of the vision, across the tactical level of coalitions and network formation to the operational level of the transition experiments. A variety of these innovative transition experiments are executed in collaboration with frontrunners. As these innovations have a focus on solving societal problems, they combine senses of urgency and actors from different parts of society. Because these innovations are at very high risk, they can be protected from normal regulations (strategic niche management (e.g. Kemp et al. 1998), for example in innovation centres). The result of transition experiments and possible changing environments will be used as feedback for evaluation and monitoring and can induce adjustments of the vision and the transition pathways. When a transition experiment succeeds, it can be scaled up to different locations and other parts of society. Successful transition experiments can have a strong influence on different sub-systems of society and on the existing regulations. This can eventually lead to system innovations and transitions.

Although transition management has been applied in different socio-technological contexts in the Netherlands (Loorbach 2007), many scholars have criticised it. In the first place, the extent to which transitions can be steered or managed is under discussion (Shove and Walker, 2007, Woodhill, 2009). Transitions in the past were evolutionary, only clarified as transition in reverse and not goal oriented. As a current phenomenon, they cannot be reduced to a single and progressive shift from one stage to another (van der Ploeg, 2009). Moreover, the intentional application of transition management is considered to have undergone insufficient testing. As such, it is challenged not only in the contexts where it has been used but also in its applicability in different non-technological sectors and in locations outside the Netherlands (Shove and

Walker, 2007; Paredis, 2009; Heiskanen, 2009). Lastly, the framework is considered to be incomplete: it needs to be enriched with other theories (Paredis, 2009; Dewulf et al. 2008). In essence, the answer to these criticisms is the further development of transition management (Heiskanen et al. 2009), to explore complementary theories (Dewulf et al. 2009), to test its value, and to clarify the relationship between top-down planned and bottom-up incremental change (Kemp et al. 2007).

Transition management uses mechanisms of planned and incremental change (Kemp et al. 2007) and places itself in between them, as a third way of goal-oriented modulation or derived incrementalism. “In terms of governance, transition management makes use of what Lindblom (1979) calls ‘partisan mutual adjustment’ but with special attention given to problem structuring, long-term goals and learning about system innovation” (Kemp et al. 2007: 79). The co-evolutionary principle already indicates that it is not possible to fully plan and control change, as other subsystems can have an important influence on a system and cannot always be predicted (Kemp et al. 2007). Moreover, opting for central steering or control can even undermine some of the best innovations and some of the most adaptive processes. Policy strategies for example are, at most, not able to tackle system failures (Kemp et al. 2007). They will merely lead to suboptimal solutions. However, by organising dialogue and collaboration between actors that represent some of these system realities, the system somehow becomes more transparent and governable. As such, transition management recognises the importance of a shared vision and its influence on change by selecting innovations that are congruent with the vision. Deliberation about a shared vision induces incremental changes towards mutual understanding of people’s mindset and ideas. Transition management furthermore recognises change in a system through daily, incremental innovations and planned, more risky transition experiments.

2.2. Episodic and continuous change concepts from organisational theory

In their review on organisational change and development, Weick and Quinn (1999) distinguish between episodic or radical, and continuous or incremental, change. In the two distinguished types of change, episodic and continuous change, an ideal organisation would be capable of continuous adaptation.

Episodic change (Weick and Quinn, 1999) starts with the idea that the ideal organisation does not exist. Due to inertia, organisations fail to adapt their deep structures to the changing environment. To be able to adapt, external interventions are necessary (1) to unfreeze the inertial system, (2) to create transition by cognitive restructuring and consciousness raising, and (3) to refreeze the system to prevent it from reverting to the old situation. The change agent is a prime mover, who creates change by focusing on inertia and seeking points of leverage to bring the system to a new equilibrium. In summary,

episodic change is induced radical change to bring an unbalanced system to a new equilibrium.

In continuous change (Weick and Quinn, 1999), recurrent interactions, improvisation and learning through self-organisation result in numerous small evolving adaptations. These accumulate and amplify, resulting in a system that adapts in the long run. The strategy is (1) to freeze the system in order to make sequences and patterns that are already there visible, (2) to rebalance it by reinterpreting and relabeling sequences and patterns and by reducing possible blockages using the logic of attraction: people do not change because they are forced to but because they are attracted to it; and finally (3) to unfreeze the system again, by resuming continuous change using the insights of (1) and (2). The change agent is a sense-maker who redirects change. As all these small changes accumulate into bigger changes, continuous change seeks equilibrium by endless modifications in work processes and social practices. Intervention in this kind of change is merely a sense-making process about what is already under way.

Sense-making is making sense of reality, as reality is a social construct that can be changed, reconstructed and reflected upon, and is a basis for action. People do this by paying attention to things in their environment, interpreting, externalising and linking them to one another and to their vision of reality (Weick et al. 2005). The process of sense-making is also about how these particular things are filtered from a large flow of ongoing experience, how a meaning is given to them, and how these interpretations are revised based on later actions and their consequences. As such, sense-making works as a frame in which a problem can be defined and which will guide attention and clarification (Weick, 1995; Weick et al. 2005). A small timescale can be a frame to make sense of change as being continuous, while on a larger timescale it may seem to be episodic. This means that both types of change are there together, and the perception of the type of change has an influence on chosen interventions: imposing change from the outside versus stimulating sense-making to create conditions where change can emerge (Termeer and van der Peet, 2009). Although Weick (2000) applies sense-making only at the organisational level, it can be applied successfully in an inter-organisational context of public policy processes (Termeer 2009) such as IS development.

2.2. Combination

Transition management and the episodic and continuous change concepts have other visions on change and are leading to different governance or intervention strategies. Transition management provides a frame for change at different levels (macro and micro). It combines episodic change and continuous change in a multi-stakeholder perspective by providing a strategy. However, it is still important to take the perspectives of planned and continuous change and their governance approach into account when analysing change processes.

Concerning planning and emergence of change, the theories propose different forms of governance. Following Weick and Quinn (1999), many studies in the organisation literature see change typically as episodic *or* continuous. The extent to which change is continuous is underestimated (Weick, 2000). It has an influence on the choice of interventions. Transition management integrates different forms of governance and places itself in between top-down planning and bottom-up incrementalism (Kemp et al. 2007) “as a third way”, a manner of goal-oriented modulation, or derived incrementalism (Kemp et al. 2007). In this way, it tends to take the advantages and to avoid the disadvantages of both types of change perspective. We think however that episodic and continuous change concepts and transition management are all equally important to understand change processes. As such, this combination of change perspectives can help in understanding and in choosing adequate governance methods for change.

3. CASE STUDY

3.1. Methodology

To illustrate the combination of change perspectives, case study research (Eisenhard, 1989; Eisenhard and Graebner, 2007; Yin 2008) was conducted on the development of eco-industrial greenhouse parks in Flanders. Data were collected from semi-structured interviews, written sources such as policy documents, spatial structure plans etc., and field notes from personal communications, field visits, observations meetings and project group meetings.

3.2. Findings

At the beginning of this article we defined an eco-industrial greenhouse park as (1) a co-location of greenhouses and (2) eco-industrial collaboration between horticulturists within the greenhouse park and with other external partners. For that reason, after giving the context, we describe the development of the co-location and of the eco-industrial collaborations separately.

Crossing the North-Flemish countryside, one suddenly sees a wall of glass near a little village. At first it looks as if the Flemish Ministry of Agriculture has created its first eco-industrial greenhouse park. As one approaches, however, things seem to be somewhat more complex. First of all, it wasn't the ministry that planned this greenhouse park, and second, it does not correspond completely with the ministry's vision of what an eco-industrial greenhouse park should be. In the ministry's vision, these parks are not only co-locations of greenhouse horticulture firms, as in this example, but also projects where horticulturists collaborate within the greenhouse park, and, where possible, with other industries to enhance economic performance and sustainability. This may be done, for example, by exchanging residual heat or by joint energy management.

Despite the ministry's best intentions, the creation of planned greenhouse parks is laborious and time consuming. Laws and rules are widely diverse and complex, and the license trajectory is long. Furthermore, a potential greenhouse park runs through many different phases, such as location choice, acquisition of land, infrastructure construction, search for horticulturists, starting collaboration, etc. All these phases require consultation with different actors with varying opinions, beliefs and goals. Different actor groups have an important stake in the process. Horticulturists, for example, are interested in obtaining a license to build a greenhouse; farmers are afraid to lose arable land; infrastructure industry is concerned about the profitability of the investments in gas and electricity infrastructure; and local people are concerned about the landscape and afraid of inconvenience such as traffic increase. Policy makers intend to have an important stake in different projects and plan them rigorously. Moreover, these groups are far from homogeneous: policy makers, for example, are from different policy levels, departments and ministries that can disagree on the location and size of a potential greenhouse park. Ministries of agriculture and spatial planning are intensively involved in these kind of planning processes, but the ministry of environment, nature and energy and the ministry of economic affairs influence important boundary conditions, such as regulations, subsidies and incentives. This makes the creation of a greenhouse park a governance exercise in a complex jungle of actors and processes.

The little village mentioned above drew up a spatial planning vision between 2001 and 2007. Because agricultural land prices increased and relations between farmers and horticulturists came under pressure, the local spatial planning group decided to divide its farmland into a zone where greenhouses could be licensed and one where these developments would be limited. Because of the scarcity of licensable space for greenhouse development (lack of legal security), gardeners were keenly interested. Within a few years, the arable land and small- and medium-scale horticultural land of the licensable zone turned into a large greenhouse park. The area is almost full now. Land is however not very efficiently used because different greenhouses were not adjusted to each other but planned independently. A location with less fertile soil could have been chosen for this footloose agriculture.

The area has only limited internal collaboration among horticulturists, as collaboration is limited to firms with a common owner and to talks among firms with a similar vision. External collaboration is however prevalent. Some greenhouse firms collaborate with external greenhouse firms (joint acquisition of inputs and transportation), and one of them receives heat from a neighbouring manure processing company.

3.3. Interpretation

At first glance, the greenhouse park seems to be mostly continuous change, because internal development of the zone has not been planned. But if we delve

deeper into the case, we find that many other actions are inspired by the philosophy of planned change, such as the intensive agricultural zone and infrastructure works to adapt the zone to its new function. Other things, such as collaboration, design and development of the intensive agricultural zone were not considered in the planning process. Within the greenhouse park, everyone who developed something new acted on their own without common project development. This led to inefficient use of the land.

▪ **Looking at the case from an episodic change perspective**, one sees that the change is merely driven by local policy makers and planners. They had to deal with the problem of increasing competition for farming land-use. Therefore, spatial planning experts studied the region and developed a local spatial structure plan together with the local policy makers. Representatives of advisory committees (controlled by local policy) functioned as stakeholders in the process but consultation of local inhabitants happened only at the end of the planning process, so that spatial planning could seem to be imposed. In hindsight, interest in the intensive agricultural zone was underestimated, as were its effects on the landscape. Furthermore, the area is used inefficiently due to a lack of coordination/planning, and local policy makers are afraid that higher policy-making levels would favour an enlargement of the greenhouse park.

▪ **From a transition management perspective**, we how an actor arena developed a spatial planning vision for the future, based on regional spatial planning studies. The transition management perspective questions whether the actor arena was large enough (were all relevant actors, such as horticulturists sufficiently included?). The arena's vision was attractive for policy makers because the community would have a proactive, greenhouse friendly policy, in comparison with their neighbouring communities, and at the same time the development of intensive agriculture could be limited in other parts of the territory. A trajectory to build the spatial vision and to ensure a participative approach has been designed, and there is a legal trajectory ongoing to make this vision enforceable. Despite this, the participative approach could be perceived as rather limited as some horticulturists bring up that they were not sufficiently included. Within the area, there seem to be not a very active approach; there was rather little communication between actors and no actor arena among horticulturists. There was no transition manager either, to initiate dialogue among horticulturists. In retrospect, the zone grew into the first greenhouse park. The local policy level gives support but is against its spatial enlargement.

▪ **From a continuous change perspective**, other issues emerge as well. Inner development of the agricultural zone was not planned or organised and there was no recurrent interaction between the horticulturists. Despite this social distance, the most successful greenhouse park in Flanders has emerged.

The combination of change perspectives furthers understanding of the process, and ideas from the three perspectives are helpful. This is illustrated with the greenhouse park case. Evaluation varies, using different change perspectives. An episodic perspective reveals a story of different outcomes and missed opportunities, whereas a continuous perspective highlights the emergence of IS and of the most successful greenhouse park in Flanders.

In terms of governance, the episodic change perspective could for example give the idea to run a study to identify the remaining options to use the land more efficiently and to make new top-down plans concerning it. Transition management supports the idea to establish an actor arena with policy makers, horticulturists and other actors, where an independent transition manager facilitates dialogue towards a shared vision on the intensive agricultural zone (greenhouse park). From a continuous change perspective, a place where actors can meet and enter into dialogue with one another can foster reflection, mutual understanding and trust, which then can make actors move to recurrent interaction and ongoing adaptations. Each perspective leads to different ideas for governance of the greenhouse park development. Taking into account the three perspectives enriches the considered governance possibilities and helps to choose an appropriate governance strategy.

4. DISCUSSION AND CONCLUSION

For industrial symbiosis, the combination of change perspectives reveals insight in change processes and eco-industrial park development, as illustrated by the case. Planned and emergent changes are not the only perspectives of organisational science that are applied to industrial symbiosis. We will use our combination of change perspectives to classify the highly differentiated literature on organisational aspects of industrial symbiosis.

First, there are concepts in the literature that can be related to all three perspectives of episodic change, transition management and continuous change. Baas and Boons (2004), for example, considered eco-industrial park development as a dynamic change process. Acquiring knowledge of the system in general is moreover very important in the industrial symbiosis literature. This can be done by analysing technological and economic issues, or through regional approaches such as the clustering approach (Porter, 1998) that sees industrial symbiosis as a kind of business cluster (e.g. Deutz and Gibbs 2008; Chertow 2007). In these clusters, coordination, trust and competitive advantage are generated through proximity of related companies and institutions in one location, and through repeated exchanges among them. Furthermore, the different forms of self-organisation in industrial symbiosis (Boons, 2008) can be related to the different change perspectives. These types are self-governance, pure self-organisation, self-organisation with imposed selection pressure (by the government) and no-self organisation. The form of self-organisation can differ at different moments in the change process. Baas and Boons (2004) integrate the

lifecycle of organisations, stages of industrial ecology and incremental change. They identify three stages in the process, in which actors make use of existing win-win situations (regional efficiency), exchange knowledge within trusting relationships (regional learning), and base their activities on a created vision of sustainability (sustainable industrial district). This knowledge is important for planning change processes.

Then there are many concepts that can be related to parts of the transition literature. As *de novo* planned parks usually are not totally planned and industrial symbiosis in existing parks can also contain planned elements and government interventions, or can be triggered by government incentives, a grey zone exists between planned and emergent change. Different aspects of transition management cover this zone between planned and emergent change, combining components of both. Adamines and Mouzakitis, (2009) and Gibbs, (2009) consider industrial ecology and industrial symbiosis as a niche development, which is unknown by the mainstream regime or for which existing roles are not appropriate. As such, it is a kind of transition experiment where failed experiments generate knowledge for future developments (Gibbs, 2009). Furthermore, a more sustainable world can be seen as a vision or transition image from the perspective of industrial ecology (Geels, 2005; Rotmans, 2005, Rotmans and Loorbach 2009) and hence industrial symbiosis. The vision and successful examples of eco-industrial parks can be inspiring and motivating for others. System analysis is a basis to start not only with problem structuring and vision formation, but also for uncovering possibilities for industrial symbiosis and kernels of industrial symbiosis and emergent industrial symbiosis initiatives (Chertow, 2007). Another overlap between transition and industrial ecology literature concerns process facilitation. Because, at present, planned examples often remain unsuccessful and many opportunities for industrial symbiosis are never taken, different management and governance strategies are required. Chertow (2007) suggests facilitation, incentives and uncovering of emergent industrial symbiosis initiatives, and Howard-Grenville and Paquin (2009) show the possible role of an organisation that serves as an innovation broker. This organisation (or person) is able to make introductions between possible partners and to be a participant in the larger stakeholder network. It (he/she) could be a transition manager or a participant in the dialogue at a more operational level, to manage processes of recurrent interactions in order to foster dialogue based on reflection on (changing) existing rules and incentives or on IS and its possibilities. As such this transition manager could manage people and thereby create an environment where continuous change in the direction of IS can happen more frequently.

In congruence with characteristic episodic change, Boons and Baas (1997) elaborated on the coordination and inflexibility of industrial ecology.

Continuous change can at first be related with emergent industrial symbiosis (Chertow, 2007). The uncovering of industrial symbiosis possibilities (Chertow, 2007) is a continuous change intervention in and of itself, which can motivate actors and prompt them to adopt industrial symbiosis collaboration. In

correspondence with continuous change, actor relations and social networks are considered to be important for industrial symbiosis (Ashton, 2008). Baas and Boons (2004) suggest that actors can make different sense of what is and what is not part of the process. This will influence who will be involved, which projects for possible future change are taken into consideration, and so on. Trust relationships are moreover very important to induce industrial symbiosis linkages (Gibbs 2003; Hewes and Lyons (2008). As such, a good governance of these actor relations could be rewarding for the industrial symbiosis process.

At the beginning of this chapter we chose the perspectives of transition management (Kemp et al. 2007; Rotmans and Loorbach, 2009) and episodic and continuous change (Weick and Quinn, 1999). The combination of these three perspectives gives a better understanding of complex issues in planned and emergent eco-industrial park development. In change management literature, however, other theories exist, such as organisational development (for example Boonstra, 2004). These theories could complete the picture, although the added value of the use of the extra theory and increasing complexity of the combination of perspectives should be balanced with the concern to generate a comprehensive combination. We therefore decided not to include more change theories in our methodology.

The combination of change perspectives reveals governance possibilities. In light of the insights on change mechanisms of episodic and continuous change and the process approach of transition management, intervention possibilities are numerous. As interventions in episodic and continuous change are less concrete than in transition management, elements of the transition management can be used as sources of inspiration or examples of how to tackle a change process. It should be interesting to investigate how to make these governance and intervention strategies more concrete.

In this chapter we have combined different change perspectives to further our understanding of less investigated aspects of eco-industrial parks. Our analysis is based on transition management theories on episodic and continuous change, and can deliver insights into various aspects of change processes. The different change perspectives were also used to classify the widely diverse literature on organisational aspects of industrial symbiosis. Taking into consideration the different perspectives on and possibilities for change processes during the entire process, this study can be used for decision making in the governance of change processes.

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Chapter 11. Developing Sustainable Livestock Production Systems. Outline of a Learning and Experimentation Strategy (LES)

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Abstract

Over the past decade, the Dutch Government has increasingly emphasised the need for integral solutions to sustainability problems in the livestock production sector. This has led to the adoption of research approaches in line with Transition Management and system innovation that were developed in other domains. In 2008, the government set further policy targets of 5% and 100% sustainable livestock production at the farm level for 2011 and 2023 respectively. Policy measures included the stimulation of sustainable agriculture initiatives in the sector and demand for projects with a focus on system innovation. Two broad approaches may contribute to the realisation of these targets, the one top-down and the other bottom-up. Top-down approaches are usually research-led and characterised by the formulation of visions for future livestock production systems. At the same time, a broad variety of bottom-up initiatives are taken by farmers, who develop and try out new approaches to meet the challenges as they encounter them. Currently, the links between bottom-up and top-down processes are relatively weak. As both may contribute to system innovation, successfully combining the two approaches constitutes a crucial challenge. To this end we have developed what we call a “Learning and Experimentation Strategy” (LES) that is presented in this chapter.

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1. INTRODUCTION

During the second half of the 20th century, the evolution of livestock production in the Netherlands was strongly influenced by politics, policy and sector representatives. The main goal was to increase production efficiency, with a strong focus on export. Gradually, this modernisation process came under criticism for its negative side effects. Early critics emphasised the dangers of chemical pest and weed control, the emanation of malodours from livestock units and mineral surpluses. Later, the emphasis shifted to impaired animal welfare and to contagious and zoonotic animal diseases, especially after outbreaks of a variety of epidemic animal diseases in the past decade, including classical swine fever, foot and mouth disease, avian influenza and BSE. Recently, criticism has centred on livestock production's contribution to climate change and its excessive drain on natural resources for food production.

Government policies have sought to resolve or mitigate these problems by stimulating research, subsidy programmes and regulatory actions. In most cases, these measures have led to specific problems being reduced through technical means and regulations for the livestock production system. Thus the agricultural system that had emerged during the first modernisation (Beck, 1992) met the first attempts at reflexive modernisation. The latter, however, also drew on various thoughts and approaches (hard and soft institutions) rooted in modernity. While the actors involved continued to increase production efficiency, they also tried to fine-tune inputs (nutrients, agrochemicals, manure, etc.) to meet societal needs.

The search for integral solutions has received increasing attention since the mid-1990s, which has led governmental policies to partially adopt research approaches in line with those of Transition Management and system innovation developed in other domains. In 2008, the Dutch government set the specific policy targets of 5% and 100% sustainable livestock production at the farm level for 2011 and 2023, respectively (LNV, 2008). Policy measures included stimulating sector initiatives for sustainable agriculture (sectoral 'innovation agendas'), requesting projects with a focus on system innovation and societal design, and subsidising instruments for agricultural entrepreneurs and integral research.

Two broad approaches have evolved to meet the challenges faced in the livestock production sector: top-down and bottom-up. Top-down approaches are typically research-led and often start with the formulation of visions for future livestock production systems. These include redesigning primary production (Bos and Grin, 2008), the inclusion of new functions in primary production, vertical integration in the supply chain and combining the functions of different agricultural activities in agro-production parks (Grin and Van Staveren, 2007). The source of these visions for sustainability varies from expert analysis only, to extensive stakeholder consultation, to deliberate co-design by scientific experts and stakeholders.

At the same time, a broad variety of bottom-up initiatives is taken by farmers, who develop and try out new approaches to meet the challenges as they encounter them. Most of these initiatives are not guided by broad future visions and focus on specific aspects. Currently, the links between bottom-up and top-down processes are relatively weak. From the top-down perspective, bottom-up initiatives are even considered risky since they typically address a relatively small problem within the current system and might solidify the system rather than opening it up, whereas top-down approaches explicitly seek to change the system as a whole.

However, a system innovation can never be 'organised from above'. It needs to draw on the 'innovative energies' within the existing livestock production sector, i.e. lessons learned in the bottom-up process. Successfully combining top-down and bottom-up processes constitutes a major challenge, which we address in this chapter.

Much research has been done on top-down approaches like Strategic Niche Management (Hoogma et al., 2002; Schot and Geels, 2008) and Transition Management (Rotmans, 2003; Loorbach, 2007). For this reason we focus on the bottom-up processes in this chapter but with the overall intention of combining this perspective with top-down approaches. We present a tentative framework to assess the potential of bottom-up initiatives, as well as top-down projects, to contribute to system innovation. This framework serves as a tool in a broad learning and experimentation strategy in which the lessons from top-down and bottom-up are combined in stimulating system innovation. We are currently (fall 2012) testing this framework in various sectors, and based on the findings we will modify and elaborate it for wider applicability.

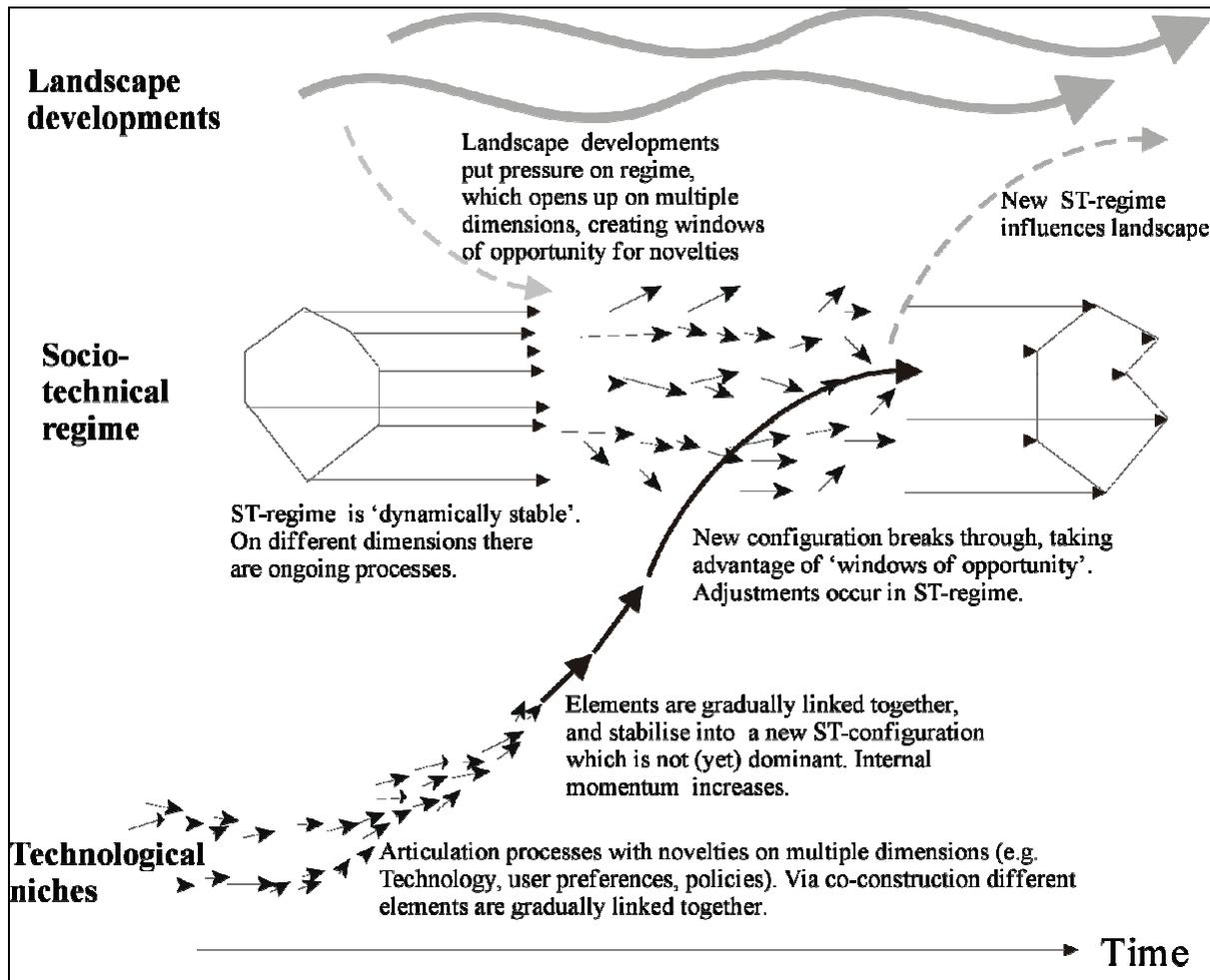
2. THE DYNAMICS OF SYSTEM INNOVATION

The central issue in this chapter is how learning and experimentation in projects may contribute to system innovation. The traditional model sees innovation as a diffusion process: via innovators, early adopters, early majority, late majority and eventually laggards (Rogers, 1962). System innovations have also been described as a sort of diffusion process, distinguishing the following phases: pre-development, take-off, acceleration and stabilisation (Rotmans, 2003).

Although more recently extensive work has shown that these diffusion models are over-simplistic, they are still widely understood to be valid in policy arenas as well as scientific communities (e.g. Gielen and Zaalink, 2003). Policy makers, after a successful project, immediately tend to ask the question: "And now, how do we scale up?" The so-called multi-level perspective (MLP; Rip and Kemp, 1998; Geels, 2002) provides a more dynamic view on innovation. The core of the MLP is that system innovations are shaped by interaction between three levels: socio-technical landscape, socio-technical regimes and technological niches (Figure 1). Socio-technical systems are located at the meso-level of *socio-*

technical regimes. These regimes indicate a set of shared rules that guide and constrain the actors within a production and consumption system in how they tackle the various challenges they encounter. This typically leads to evolutionary patterns of innovation. The *socio-technical landscape* is an exogenous environment of factors with a broader societal relevance, like the need to reduce CO₂ emissions. *Technological niches* are the breeding ground for radical innovations that initially fit the regime poorly.

Figure 1. A dynamic multi-level perspective on system innovation (Geels, 2005)



In the MLP dynamic, system innovations develop as follows. A novelty emerges in a local practice and becomes part of a niche when a network is formed of actors that share certain expectations about the future success of the novelty, and are willing to fund and work on further development. Niches may emerge and develop partly in response to pressure and serious problems in an existing regime which can be either internal to the regime itself (such as animal welfare in industrial animal production) or come from the socio-technical landscape (e.g. the pressure to curb CO₂ emissions which affects more than just the animal production sector). The further success of niche formation is linked both to processes within the niche (micro-level) and to developments at the level of the

existing regime (meso-level) and the socio-technical landscape (macro-level). Supported by actors willing to invest in the new concept (industries, R&D organisations, government) and initially protected from competition in the market place (e.g. through subsidies), the technology is improved within the niche, broader networks are formed around it, and more is learned about directions for improvement and the functions it may fulfil.

After some degree of improvement of the technology, and as more is learnt about its potential, it may come to serve for specific market applications, often typical segments that exploit new functional characteristics of the technology and focus less on cost structures (e.g. organic food). With further improvements, increasing reliability, and cumulated experiences and learning about its functionalities and potential applications, the technology can spread to other market niches and/or trigger the expansion of market niches. An important role is also played by processes of rule formation, such as the development of standards and regulations for the technology, and processes to reduce mismatches between the emerging technology and the rules of the dominant regime. As it starts to compete in or with main markets, the novelty may transform or substitute the existing regime and thus trigger a system innovation process.

This perspective allows for a very dynamic view on innovation processes, as its application to a variety of historical cases has shown. These studies, however, tend to focus on the vicissitudes of a specific alternative technology to an existing system (e.g. sailing ships replacing steamships; Geels, 2002) although the new technology does not simply spread but also changes in the process. While this is fine for retrospective studies, it is problematic to use as a heuristic tool in a 'learning and experimentation strategy' seeking to contribute to system innovation. We do not know which alternative development will play a key role in the shift towards a sustainable livestock sector. We need to acknowledge that 'innovation in action' is a lot messier than retrospective historical studies portray it. (See e.g. Elzen et al.; forthcoming).

3. PORTFOLIO OF PROMISES

In the MLP, niches are the core locus for learning about and further developing novelties. A niche consists of a variety of projects that share a technical nucleus, e.g. electric propulsion for cars (Hoogma et al., 2002). However, using the niche concept in a sector like animal production is problematic because innovative projects and practice initiatives are widely diverse. For instance, they may relate to new types of animal food, new manure collection technologies, new husbandry systems, etc. As mutual learning between these initiatives is often minimal, they do not fit the definition of a niche in MLP.

To address such innovations we will use the term 'promise'. The term promise expresses the idea that each of these novelties has appealing characteristics from a certain sustainability perspective (e.g. lower CO₂ emissions), but also has

problematic (e.g. more expensive) or unknown dimensions. Initially, a promise may just be an idea or a concept, explored in a single project. After a certain period of time more projects may follow in connection with the promise. When these projects start exchanging information the promise may thus develop into a niche.

Historical cases show that system innovations are not the result of the ‘massive diffusion’ of a new technology but a lengthy process of combining and re-combining ‘partial innovations’. This implies that, to induce or stimulate system innovations, the attention should not be on a single novelty (or promise) but on a range of novelties that we call the ‘portfolio of promises’. In a project seeking to develop a new ‘integrally sustainable’ husbandry system for dairy cows (“Kracht van Koeien” (Cow Power); cf. Bos, 2009), we identify about a dozen such promises, including the separate collection and processing of manure and urine, a minimum space of 360 m² per cow throughout the year, cheap but sustainable roofed shelters (rather than a closed barn), etc.

For each of these promises a learning and experimentation process is needed to find out how problematic aspects may be resolved in practice, and to explore whether new sustainability problems are created. For an individual promise, even if it does not (yet) constitute a niche, the Strategic Niche Management (SNM) approach provides valuable suggestions on how to do this (Hoogma et al., 2002; Schot and Geels, 2008). However SNM looks at the level of a single novelty and not at the portfolio level, i.e. across a variety of niches in MLP terms. To make a more encompassing contribution to system innovation, we need a learning and experimentation strategy that works at two levels: the level of individual promises and the level of the portfolio of promises.

The **individual promise level**: because we are looking not only at technical innovations but also at new practices, new meanings, etc., it is important to make various stakeholders, to whom the experiment may be relevant, part of the network exploring it (e.g. the ‘roofed shelter network’ in the Cow Power project mentioned above). Because a wide variety of ‘partial innovations’ will be required for a system innovation, a large number of such networks will be required over a long period of time (as system innovation tends to be a lengthy process).

The **portfolio level**: because a system innovation will result from a process of combination and recombination of partial innovations, it is important to analyse how various promises might be linked to create a full system that is more sustainable than the existing one. Such an analysis at the portfolio level (the ‘portfolio integration’) may lead to new experiments with associated promises (thus creating a new, more comprehensive promise) or may offer feedback for ongoing experiments to include certain aspects based on the portfolio integration. Because a variety of promise networks need to be running for a longer period this portfolio integration should be a more or less continuous activity.

We call this combination of learning and experimentation at two levels the “Learning and Experimentation Strategy” (LES). It can be seen as a twofold extension of SNM: (1) it addresses promises before they constitute a niche and (2) it looks at a range a promises (or multiple niches in SNM terms). In the next section we show that LES also extends further than SNM (as well as Transition Management) by incorporating ‘top-down’ as well as ‘bottom-up’ initiatives.

4. TWO COMPLEMENTARY LES APPROACHES: TOP-DOWN & BOTTOM-UP

Historical system innovations have rarely been planned and they usually developed solely out of bottom-up processes. The idea of deliberately bringing about system innovations to meet societal goals (like sustainable animal production) is relatively new. In top-down approaches like SNM and Transition Management (TM), organised projects are crucial to achieving this. Organising projects, however, does not imply that the bottom-up dynamic has been halted, something, which is overlooked in SNM and TM. A ‘complete’ approach to invoking system innovations should combine the top-down and the bottom-up processes. We will discuss each of these below.

4.1. Top-down

Generally, top-down approaches are research-led and start with the exploration of possible sustainable futures (Hirsch Hadorn et al., 2008). The nature of such explorations varies widely and could be based on the extrapolation of trends, scenarios, dynamic modelling, elaborating visions and actions of co-design or *ad hoc* methods to define requirements for a future system without the limitations of the existing one. Future explorations serve functions like giving direction to short-term actions, a certain loosening up from today’s preoccupations and achieving openness and congruence among stakeholders about a future orientation. Smith et al. (2005) distinguish the following functions of a future exploration or vision-building exercise:

- Mapping a ‘space of possibility’: Visions identify a realm of plausible alternatives for conceiving of socio-technical functions and providing the means for them to exist.
- Serve as a heuristic device: Visions act as problem-defining tools by pointing to technical, institutional and behavioural problems that need to be resolved.
- Provide a stable frame for target setting and monitoring progress: Visions stabilise technical and other innovative activity by serving as a common point of reference for actors collaborating on its implementation.

- Serve as a metaphor for building actor networks: Visions identify relevant actors (by inclusion and exclusion), acting as symbols that bind together communities of interest and of practice.
- Provide a narrative for focusing capital and other resources: Visions become an emblem that is employed for marshalling resources from outside an incipient regime's core membership (see also Rotmans, 2003; Loorbach, 2007; Berkhout et al., 2004; Brown et al., 2000).

In the Netherlands, the Sustainable Technological Development (STD) approach (Weaver et al., 2000) has gained considerable attention. It starts by constructing visions of a desirable future and then uses a method called backcasting to define short-term actions. Backcasting is carried out in interaction with stakeholders (Quist, 2007). The Transition Management approach follows a comparable methodology (Rotmans, 2003). Here a 'basket of visions' is developed with a variety of stakeholders, which are also 'translated back' into concrete projects in the near future.

In our view, these top-down approaches to developing the future are too planning-driven. Innovation in practice is a very messy process in which a wide variety of stakeholders are active and one of the challenges is to use the 'innovative energy' that is already there. To achieve this, we have been involved in vision-building exercises with sectorial stakeholders for various livestock sectors, including laying hens, broilers, pigs and dairy cows. Most of the time the visions take the form of a report or brochure outlining the general 'contours' of more sustainable husbandry systems for a sector along with concrete suggestions for various 'sub-systems' (the 'promises'). Via various communication outlets we made these images widely known to the sector and invited farmers to try and implement various aspects of the proposed system on their own farm. For laying hens, this resulted in a new system by the name of Roundel that is currently experimented with by farmers (Groot Koerkamp and Bos, 2008; Klerkx et al., 2009). For dairy cows, visions of four sustainable new systems were launched in early 2009 (Bos, 2009); and we have frequently been approached since by farmers who want to try out aspects of these systems. One of the promises now tried out by various farmers are new floors for cow houses. New floors could make contributions to aspects of sustainability, including animal welfare and the reduction of emissions (especially of ammonia with the early separation of manure and urine).

4.2. Bottom-up

The initiatives that these visions inspire can be seen as part of a 'top-down' dynamic which is driven by the explicit goal of developing 'integrally sustainable' husbandry systems. However we need to be modest as most of the innovative activity in a sector develops from the bottom up, and much of this is *not* (or

hardly) influenced by global sustainability visions. Since these 'bottom-up' initiatives by far outweigh top-down initiatives as far as numbers go, this begs the question of whether and, if so, how bottom-up initiatives could also be incorporated in a learning and experimentation strategy.

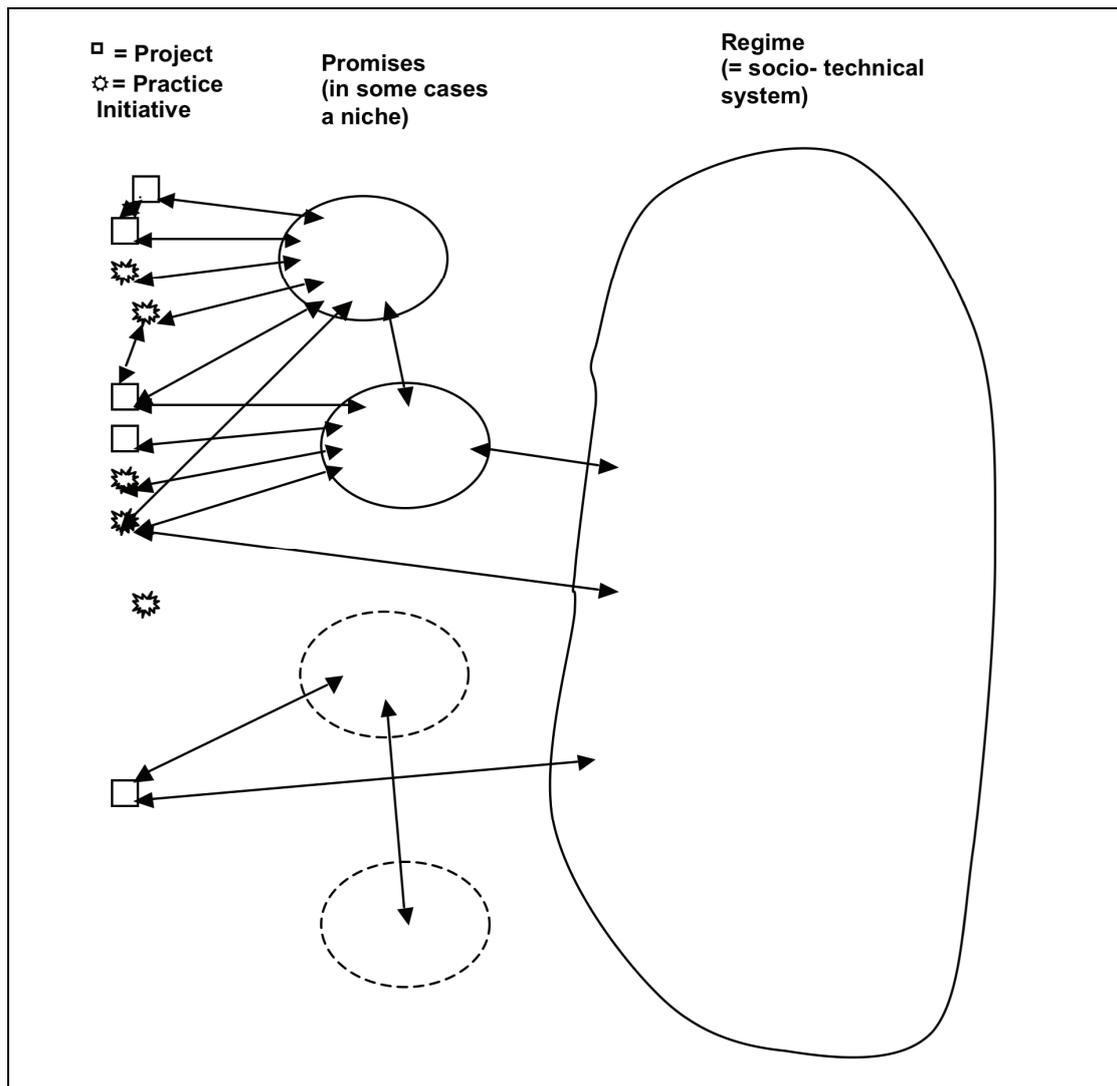
Let us take a closer look at this bottom up process, i.e. the ongoing process of innovation in the animal production sector that takes place for a variety of reasons. This does not mean that such actions are not guided by visions. They usually are, but these visions tend to be of a more local nature or address a specific dimension of sustainability (rather than the 'integrally sustainable' visions of top-down approaches).

The agricultural (including animal production) sector can be understood in two different ways. In the first, agriculture basically refers to primary production on a farm, with the goal of producing all sorts of food products (called 'conventional agriculture'). By far the largest volume of agricultural products is produced in a rather uniform fashion. Important characteristics of this system are cost price competitiveness and production for international food corporations (cf. Van der Ploeg, 2008). Innovation is driven by this competitiveness. Other directions for innovation are neglected and the embedding of agriculture in the existing system is considered self-evident. Visions of change are confined to the farm level or the desire that the food-processing industry take the lead (cf. the 'Innovation Agenda' for the pig husbandry sector in the Netherlands). From this perspective, local innovative initiatives are hardly relevant. They may lead to nice niche products but they will hardly contribute to sustainable development.

In the second view, by contrast, the multitude of local initiatives is seen as a potential source of change and inspiration. These initiatives are not only seen as an effort to innovate at the farm level but they are inseparable from their institutional context. Roep et al. (2003) refer to this process in the agricultural sector as 'technological-institutional' design, which is connected to what they call 'effective reformism'. Their basic idea is that, especially in the agricultural sector, farmers' initiatives typically aim at simultaneously bringing about technical change and creating a new institutional environment (new routines and links with various stakeholders, including advisors, supplier and processing corporations, public authorities, the general public, etc.). In this process, the expectations of farmers as well as the other stakeholders change. Thus, such initiatives may form the 'seeds of transition' (Wiskerke and Van der Ploeg, 2004; see also Roep and Wiskerke, 2006) although they are not guided by 'integral sustainability' visions.

This means that such bottom-up initiatives are certainly relevant to a learning and experimentation strategy for sustainability. LES should analyse the contributions of such bottom-up initiatives, as well as the potential and actual contributions of top-down organised projects to the development of individual promises and the portfolio as a whole. This is captured in Figure 2, which gives a representation of the multi-level dynamic, focusing on the relationships between projects, practice initiatives, promises and the regime.

Figure 2. LES concepts in the multi-level dynamic



Some explanatory remarks concerning the figure:

Two-way arrows are used to indicate that influences may go both ways.
 Projects and initiatives may contribute to more than one promise.
 Some of the promises are shown in dashed lines, indicating they are (still) conceptual ideas that are not or are hardly supported by a network. One of these is not supported by any project or initiative, indicating it is still just a conceptual idea.
 Projects and practice initiatives may influence each other directly.
 Projects and practice initiatives may also have a direct influence on the regime.
 Promises may also influence the regime.
 Promises may influence one another.
 One isolated initiative is not connected to any promise as an example of many such initiatives that do not fit the portfolio of promises.

5. ASSESSING PROMISES

Farmers implement innovations for a variety of reasons. There may be thousands of such initiatives, some of which may be inspired by sustainability motives while many others are motivated otherwise. This raises the question of how to assess which initiatives might make a contribution to sustainable development. This is not simply a matter of listening to the farmers' motivations, as historical studies show that later developments may take very different directions from those intended or aspired to by the initiators.

We can approach this issue in various ways. Firstly, we may ask the question "Which initiatives are sustainable?" This may sound like an over-simplistic question but it is one that the current political situation in the Netherlands (as well as in many other countries) confronts us with. A 2008 white paper from the Minister of Agriculture states that by 2011, 5% of the Dutch husbandry systems should be sustainable (LNV, 2008). Therefore, the Ministry needed criteria to measure whether the target had been met. In the Netherlands such criteria have been and are being developed in the form of sustainability indexes for various agricultural sub-sectors. These indexes provide criteria that are assessed in a quality assurance scheme. (cf. www.smk.nl)

The second approach to assessing bottom-up initiatives is to see them as part of an ongoing process. The question then becomes: "Which initiatives have a potential to contribute to sustainable animal production?" This requires a broader set of assessment criteria such as the presence of a broader vision on sustainability, institutional embedding and change, risk insurance for individual farmers, room to learn and experiment, potential to eventually implement the innovation in a commercial setting (e.g. via initial financial support), etc. Such criteria are more qualitative than under the first approach and more open to debate.

A third approach would consist in reversing the question: "How can we use these initiatives to learn about possibilities for sustainable animal production?" The initiatives are then seen as learning experiments to produce knowledge on barriers and opportunities for sustainable development. They can thereby become part of the 'portfolio of promises' within LES. This requires a process of continuous monitoring of innovations explored in the animal production practice, and an assessment of the relevance of locally learned lessons within the broader portfolio.

An important aspect of this third approach is that bottom-up initiatives (especially when analysed in conjunction with top-down projects) can be used to learn about uncertainties. Some of the main uncertainties are: (1) whether the innovation envisaged compares favourably to existing practices; (2) whether the innovation produces new unforeseen risks when applied over a longer period of time and on a larger scale; and (3) how the innovation potentially compares with other competing solutions. Furthermore in connection with the overall goal of

system innovation, a major uncertainty is whether the combination of top-down and bottom-up learning and experimentation might eventually weaken the existing regime and lead to a shift towards another socio-technical system.

In LES, we follow a combination of the second and third approaches. The points raised above suggest that we need a tool to assess the various promises, based on their potential contribution to sustainable animal production. Tentatively, we are now using an evaluation framework in which we assess each initiative based on the following dimensions:

- **Sustainability gains/losses:** an assessment of whether the novelty might improve sustainability at the level of various people/planet/profit sub-dimensions and animal welfare;
- **System renewing potential:** an assessment of whether the promise might help break the lock-in in the existing system;
- **Risk of strengthening lock-in:** conversely, is there a risk that the innovation might consolidate the existing system and block further renewal for a long time to come (e.g. because of huge investments made)?
- **Giving momentum to change processes:** does the novelty set things in motion that can be expected to continue for a considerable length of time?

For each of these main dimensions we distinguish various sub-dimensions. We are currently (fall 2012) testing this framework by applying it to the dairy cow and greenhouse horticulture sectors. We are exploring whether this leads to a meaningful comparison of various promises (top-down projects as well as bottom-up initiatives) and whether this serves as a good starting point for an analysis at the portfolio level. This empirical testing is likely to lead to some changes in the methodology and thus help us to refine the Learning and Experimentation Strategy that we seek to develop.

6. IMPLEMENTING LES

To implement LES, we started to develop the portfolio of promises for one specific sector, notably the dairy cow sector. In essence, the portfolio can be seen as a huge database that provides various pieces of structured information on each of the promises that it contains. This information covers aspects like:

- Description of the novelty;
- Expected contribution to sustainability (on about a dozen dimensions);
- Valuation of the novelty by different stakeholders (approval or disapproval);
- Barriers for implementation (about a dozen different barriers distinguished);
- Network of actors involved;

- Lessons learned and state of affairs.

Early 2012 we have used this approach to make an overview of renewal activities in the animal husbandry in three sectors (pigs, dairy cows and poultry) in the Dutch province of Limburg. This was part of a provincial initiative (supported, i.a., by the provincial authorities and the farmers representative organisation LLTB) to stimulate sustainable animal production in the province. In an interactive setting with innovative farmers and other stakeholders it appeared that this overview triggered a lot of creativity on possible new activities.

To be able to use the portfolio, various filters will be developed. Users may, for instance, select promises that address either specific sustainability challenges or promises that address a broad variety of sustainability challenges. It will also be possible to use it at the portfolio level by searching for groups of promises, which, when combined, address a wide range of sustainability challenges.

At this point it is essentially researchers who are involved in the development of this tool, but in the long run LES will be able to work only if various stakeholders become committed and involved. We have therefore started to explore ways of making this happen. We are attempting to link LES to a Dutch initiative called the 'Implementation Agenda'.¹² This Implementation Agenda is an agreement between various parties to actively work on the implementation of a system innovation towards sustainable animal production for the next fifteen years. It was signed by a variety of parties in 2009, including the Ministry of Agriculture, sector representatives and NGOs. The Implementation Agenda specifies a variety of challenges that should be addressed but not how this should be done (Uitvoeringsagenda, 2009). In our view the LES approach offers a good method for implementation.

We have therefore opened talks with people who are responsible for the implementation of the Agenda. If we can convince them that this is a good method to achieve their goals subsequent discussions will have to address who will be responsible for what and who will execute which tasks. In our view, who will 'own' the portfolio, who will maintain it and keep it up-to-date, who will make portfolio analyses, etc., are issues that still have to be decided on. Ideally, this should become a shared responsibility between all parties involved. As researchers, we think we could make important contributions but we can only do so if various stakeholders are also committed and agree to play active roles.

¹² "Uitvoeringsagenda" in Dutch. In full "Uitvoeringsagenda Duurzame Veehouderij": Implementation Agenda Sustainable Animal Husbandry.

7. CHALLENGES FOR FURTHER LES DEVELOPMENT

We are developing LES as a strategy to contribute to system innovation via a combination of learning from projects and learning from practice initiatives. Fulfilling this ambition presents a number of challenges and raises various questions. Below, we list some aspects that need further elaboration:

Promises monitor. Various system innovation projects in the Netherlands are being monitored to optimise learning, but it is necessary to extend this to the monitoring of practice initiatives. This raises various new questions, e.g. which of the numerous initiatives should actually be monitored? The evaluation framework in the previous section can be used to help make such decisions.

▪ **Promises analysis and evaluation.** The results of a variety of projects and bottom-up initiatives need to be evaluated in relation to one another. But how to do this and translate it into topics for further exploration (e.g. via new projects) is a matter that still needs to be defined. The evaluation framework above provides a first stepping stone for this.

▪ **Portfolio analysis and evaluation.** The next step is to move beyond the promises level and analyse the data collected at the portfolio level. We still need to develop methods to collectively evaluate data on various promises and relate them to one another. One starting point may be to evaluate the data against the background of various visions of a sustainable new system (e.g. as developed in the Cow Power project) but this would still require new evaluation methods.

▪ **Portfolio management.** In the present situation, management takes place at the level of projects and, to a lesser extent, at the level of programmes. A Learning and Experimentation Strategy, however, would also require forms of management at the portfolio level which are currently non-existent.

▪ **Stakeholder management.** A system innovation will require contributions from a variety of stakeholders, which can occur only by involving them in various activities in LES. However, who to involve in which of the tasks above is still an open question.

8. CONCLUSION

The societal and political pressure to develop more sustainable animal production systems (as well as other agricultural systems) has grown over the past decade and is not likely to go away. Meeting these expectations will require system innovations in various sectors (such as animal production) and sub-sectors (e.g. dairy cows, pigs, etc.). Approaches like SNM and TM have provided a variety of suggestions on how to use learning in series of projects to contribute to sustainable development.

However what these approaches overlook about the ongoing dynamic within these sectors is the fact that a large number of stakeholders are tinkering with a variety of innovations trying to solve a range of problems as they experience them. Historically, in system innovations such bottom-up processes were the dominant drivers of transitions. Current attempts that seek to bring about system innovations towards sustainability therefore cannot ignore this bottom-up dynamic and should make it part of their strategies.

The LES approach that we propose here does acknowledge this bottom-up dynamic. It attempts to combine the learning that takes place in bottom-up practice initiatives (often farmer-led) with the more deliberate attempts at learning in planned projects that are often research-led. This combination does more justice to the innovation dynamic that is actually taking place than the more narrow focus on projects by approaches like SNM and TM.

Combining top-down and bottom-up in LES also allows for the strong and weak dimensions of each of these approaches to be combined, namely:

- Top-down approaches are driven by the development of a vision (or set of visions) of an integrally sustainable new system. Thus, sustainability goals are embedded in the process. Their weakness is that these new visions and their constituent parts (the promises) do not fit in well with the existing system. This makes it difficult to ‘anchor’ (cf. Elzen et al., forthcoming) these novelties within the current system and to gain practical experience. Yet anchoring is needed to get a transformation process going. Starting this process ‘from the outside’ is difficult and may trigger a lot of resistance.
- In bottom-up initiatives such anchoring is guaranteed since the initiatives come from within the existing system. But because of this anchoring it is difficult to include broader sustainability issues, which would require more radical steps.

In current practice (as well as in transition initiatives in other sectors), top-down (i.e. driven by integral sustainability visions) and bottom-up constitute separate approaches. Certain parties may be working only on one approach, and hardly be in touch with parties working on the other approach. Both, however, will contribute to the system innovations in the making. Furthermore, because each approach has its weak and strong sides, it is important to combine them into a learning and experimentation strategy, LES.

Current policies often make a distinction between improving sustainability in the short term by adapting existing systems and working on integral sustainability in the long term through system innovation. While bottom-up initiatives are primarily seen to contribute to the former, this is a limited view. Judging such initiatives on direct sustainability criteria may indeed provide information on their potential to make short-term contributions. However, incorporating other criteria as well (cf. the evaluation framework above) may reveal their potential to contribute to more integral sustainability in the long term as well. This also offers the opportunity to link learning from bottom-up initiatives to learning in various top-down inspired projects. Furthermore, by ‘zooming out’ to the

portfolio level, an integral analysis may generate new ideas on how linking various promises together (irrespective of whether they come from top-down or bottom-up) could contribute to a system innovation through the identification of a 'higher level' promise. This type of broader learning and experimentation strategy therefore attempts to combine (1) top-down and bottom-up approaches and (2) the individual promise (which in some cases may be a niche) and the portfolio levels. It thus seeks to make much more effective use of existing innovative potential in the sector than other approaches and is likely to make a larger contribution to the development of a sustainable livestock production sector.

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¹³ The title of this chapter emphasises "doing" and is inspired by the perspective on reflexive innovation developed in Wageningen UR (Bos, 2008; Bos and Groot-Koerkamp, 2009). The description of this project is based on Grin et al., 2003, Bos and grin, 2008 and on personal communication with one of the programme designers, April 7th, 2010.

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Chapter 12. The sustainable fibres of generative expectation management: The “building with hemp” case study

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Abstract

This chapter accounts for an emerging logic underpinning the governance of innovation at the level of socio-technological regimes facing expectations and promises for emerging industries. Beyond the scientific literature on management of R&D resources, IP rights and core competences, we question the governance of innovation when it consists in managing the dual expansion of expectations (value landscape, creation of new visions and new interests, etc.) and the realisation of those expectations in organisational arrangements at the niche level. This chapter shows that generative expectation management is clearly based on innovative design activities, i.e. on the capacity to create and refine many possible futures within research processes and socio-technical arrangements. It suggests that efficient generative expectation management would benefit from tools and processes able to support innovative design processes.

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1. INTRODUCTION

In cases of systems innovation and radical change in emerging industries, the innovation process seems doomed to experience costly cycles of hype and subsequent disappointments. Expectations are a vital element as they encourage different actors to commit to the process; but the initial promises are often not realised due to the numerous unknown quantities and stakeholders that come into play. This leads to disappointments, to costly cycles and slow convergence towards solutions and sometimes to the end of collaborations. Can these cycles be avoided? Is it possible to manage expectations in cases of systems innovation? To address this issue, we made a detailed study of the emergence of a new industry, which shows unusual features of expectation management: hemp-based construction.

Over the last two decades, a whole industry has emerged around the use of a natural fibre, like hemp, straws, flax, as a “new” construction material. The growth of this new industry has proved to be a long, unpredictable journey based on a number of experiments. What was initially no more than an emerging network of actors gradually became an industry, which tends now to be a robust business with a host of coordinated actors: biomass producers and transformers, lime producers, architects, entrepreneurs, masons, prescribers, state agencies, insurance companies, research labs, etc. The industry is now based on new products, services, competencies and publicly recognised R&D programmes. The process has been a clear success in systems innovation: with neither large financial resources nor the intervention of a prominent, powerful actor, it has been more the result of a *collective process* based on the active cooperation of heterogeneous actors (with different backgrounds, expertise and goals) with a range of scattered, different competencies who succeeded in turning a small, somewhat unlikely project into a successful collective enterprise. In this process, expectations were raised to create the ‘bundle’ of actors and to support their action. Later, these actors also created expectations to attract the interest of large companies (material and construction firms) and public agencies interested by the promise of sustainable construction using natural fibres.

In the case of hemp-based construction, it is important to stress that the success was anything but predictable. The actors had limited resources; industrial hemp was a marginal crop grown in small areas of land, with small R&D investments and a public image associated with the use of illicit substances, even though industrial hemp is different from the varieties cultivated for such purposes. These were clear obstacles. Expectations helped to overcome them, but strangely enough they did not create the usual pathologies identified in the literature of innovation studies. In this kind of situation, we could have expected to find cycles of expectations, hype and disappointment, and finally one winning paradigm (or a collective failure). Our empirical investigation was carried out under a question that became a constructive enigma: how did this cooperation between a small

network of actors become a large-scale design process, which is now recognised as an industry and a legitimate research and innovation field? Of course, the answer could simply be that it was a fortunate realisation of the initial promise. However, when we analysed the matters of facts to be discovered in this case study, we found that there was more to it than a single expectation in the usual phenomenology. In hemp building, we discovered a new way to deal with expectations, which we labelled “generative expectation management”, addressing an ongoing thread of scientific discussion in the growing literature about expectation and innovation through a case study.

A recent body of literature underlined a fascinating phenomenology of expectations, showing striking features in cases of systems innovation. Such situations tend to create hype and disappointments that can be linked to technology-driven speculative bubbles; these bubbles repeat over time in cycles of expectations, which can sometimes slowly converge towards economic growth. The phenomenology also identifies two types of expectations: rational expectations, with a clear promise of profitable investment, and “second-order” expectations (Borup et al., 2009), i.e. expectations that enable first-order ones. It is these second-order expectations that occur in cases of systems innovation. We propose that second-order expectations be called “generative expectations” as they are a condition of rational expectations. Whereas quite a lot is known about the management of rational expectations (clear promise, attracting funders, basing funding on the value of the realised promise), the same cannot be said for generative expectations. Moreover, it appears that when generative expectations are managed as if they were rational ones this leads precisely to the pathologies described above, i.e. fragile collaboration with non-relevant stakeholders, resulting in repeated, costly cycles of hype and disappointment. Managing generative expectations is hence an open research question.

The hemp case is an exemplary case of generative expectation management, which did not lead to the classical “pathologies”. Through an in-depth case study, using the most recent analytical frameworks available to study proposals on partially unknown objects (C-K design theory), this chapter describes a new model of generative expectation management. We show that generative expectation management is based on the dual, simultaneous and complementary realisation of promises and the renewal of promises; that it is aimed at committing designers (instead of funders); and that it is based on the creation of a common space for collective, innovative design, managed as a common good.

2. ANALYTICAL PERSPECTIVE AND RESEARCH QUESTIONS: GENERATIVE VS. RATIONAL EXPECTATION MANAGEMENT

2.1. A phenomenology raising critical issues for the management of expectations

The literature has helped uncover a phenomenology of expectations, which is particularly visible in Van Lente's cases (Van Lente, 1993; Van Lente and Rip, 1998), in Geels and Raven's Biogas case (Geels and Raven, 2006) and in Robinson and Propp's study of lab-on-a-chip technology (Robinson and Propp, 2008b). Expectations have been described as a "natural" phenomenon associated with radical systems innovation (Smith, Voss and Grin, 2010). As underlined by Borup et al. (2006: 2329), expectations can guide activities, provide structure and legitimacy, attract interest and foster investment. They give definition to roles, clarify duties, offer a common perception of what to expect and how to prepare for opportunities and risks. They help to mobilise resources at all levels and to build bridges across boundaries and between communities or groups, or between different levels or scales and different times. However, these phenomena are not necessarily positive and also raise critical issues.

First, with respect to the effects of expectations: they are supposed to create hype – and hence involvement, engagement, investment, etc. - but, as several authors (Borup et al. 2006, Callon, 1993: 2489, Nowotny, 1997: 2490) have pointed out, they may also generate disappointment by creating lasting damage to the credibility of industry, professional groups and investment markets: "Expectations are accompanied by serious costs in terms of reputations, misallocated resources and investment" (Borup et al. 2006). Geels and Raven have also shown that they are *highly sensitive to external factors* (influence of oil price on biogas investments for instance) (Geels and Raven 2006); and van Merkerk and Robinson have focused on the creation of 'irreversibilities' (van Merkerk and Robinson 2006). Some authors have shown that expectations follow cycles linking them to requirements, and that these cycles can converge (requirements are met) or diverge (when requirements are unmet, i.e. expectations are not fulfilled, new promises have to be created) (Van Lente, 1998: 2337; Van Lente, 1993: 2487; Geels, 2006: 2330).

Second, with respect to the people involved: expectations support alignment towards a single shared vision, but this alignment can prevent exploration and divergence (Van Lente 1998). Expectations are supposed to involve actors, but cognitive models of expectations and uncertainty (Sung and Hopkins 2006) have underlined that some expectations tend to involve non-experts, who are less sensitive to uncertainties, contrary to experts who are more knowledgeable about uncertainties and therefore believe less in the expectations, with the effect of downsizing alignments.

This phenomenology therefore calls for a system of management capable of taming the negative effects whilst keeping the positive ones. Following the

programme traced by Borup et al. (2006), we propose to investigate how to avoid exaggerated expectations or hype, without throwing the baby out with the bathwater. What can be done to prevent disappointment from undermining the things that hype is supposed to achieve, such as attracting interest and investment? Expectation management consists in finding a balance between two traps: the first risk is that *expectations are too low to provoke commitments*; the second is that *expectations are too high and hence too sensitive to disappointments*. More generally, we must not only analyse the phenomenology of expectations, but also address the question of how they are managed, i.e. the way in which they can be collectively produced, built up, shared and used as a basis for collective work.

2.2 Contrasting two models of expectations management: anticipative expectations management vs generative expectations management.

The issues raised by the phenomenology of expectations might be due to the fact that there are two very different types of expectations management, associated with two different types of expectations, which are clearly distinguished in the literature.

Expectations as rationale anticipations

The first model is very well described in Propp and Moors' synthesis (Propp and Moors 2009). The authors give the following definition: "*An expectation is an anticipation of the kind of future that may be 'on its way' from within the present. Anytime we speak of a 'trend towards (x, y, z)', we actually extrapolate current events into the unknown ahead; experience may tell us in some instances which outcome is likely, but the results have not occurred yet and are uncertain.*" Expectations can be managed so that they follow that pattern: "*Actors simultaneously talk up the deterministic momentum of current developments and suppress uncertainty and alternative futures, hoping for alignment of other actors - and the resources they have or can distribute - around these expectations*" (Propp and Moors 2009).

We find several examples of these kinds of expectations in the literature. For instance, Geels and Raven 2006 showed that in the 1970s biogas development was based on the expectation of "cheap alternative energy generation" based on existing knowledge on digestion and, later, on the promising outcomes of a pilot plant in 1979. In van Merkerk & Robinson (van Merkerk and Robinson 2006) the authors studied a "micro-total analysis system", giving the following example: "*In 1993, Harrison and Manz revealed a large breakthrough in the journal Science with a successful miniaturization of the analytical technique of capillary electrophoresis*". They articulated their expectations as follows (p. 897): "*The application of micromachining techniques to the miniaturization of chemical analysis is very promising and should lead to the development of analytical laboratories on a chip.*' Typical advantages of chip-based analysis systems are

speed, less sample needed and possibly portable.” In both cases it is expected that there is a high probability that a new piece of knowledge A_s (in the example above, micromachining techniques applied to chemical analysis) will give a future F (in the example above, “analytical laboratories on a chip”) that meets performance criteria (or more general speaking sources of users value, called S) (speed, portability, small sample,...). The anticipative expectation is the probability to realize F given the assets A_s $P(F/A_s)$ to get the value of F given the sources of value S_s , $V(F/S_s)$.

We can underline that these anticipative expectations are constructive in the sense of Borup et al.: there is not necessarily a “real” future F , this F can be imagined and figured out by people at a certain moment of the innovation process. We call them “anticipative” because people need to figure out what the future result will be and decide to “take” this future F or not (anticipate, according to the Latin root *ante-cipare*, means to take in advance).

How is this type of expectation managed? The “expectation raiser” has to design the good sentence “ $A, S \rightarrow F$ with a high value $V(F/S)$ and high probability of success $P(F/A)$ ”. An anticipative expectation is well-formed when it meets certain criteria: the value of the future state $V(F/S)$ has to be desirable and clear; the probability of reaching F also has to be high and warranted by the initial asset (A). In negative terms, this implies that F should not be emerging, partly unknown or partly undefined. The design effort linking A and S to F has to be minimized. One does not expect changes in A_s and S_s that would change $P(F/A)$ and $V(F/S)$.

These expectations address a clear, mobilizing (already known, self-evident) value, which is not supposed to change during the realization of F . The expectation raiser tries to prove that the relationship between A , S and F is almost certain (almost deterministic). It is expected that the asset A and the sources of value S will enable the realization of F and its associated value. *Ideally, anticipative expectations are design-free.* Anticipative expectations provoke an alignment of the actors towards F , based on A and S . Alignment means three simultaneous effects regarding collective innovation:

- it leads to identify a network of partners
- it supports their coordination (division of labour) to realize F
- it supports their cohesion (common interest) , based on sharing the value of the future F

As underlined by Sung et al., in this type of expectations, experts and designers aware of the uncertainty, risks and design efforts expect less (Sung and Hopkins 2006). Anticipative expectations mobilize funders ready to pay for A in the hope of F . There is a clear asymmetry between the expectation raisers - who establish the relationship between A , S and F - and the people carrying the expectations.

Anticipation as second-order expectation

Borup et al. suggested that there is another model of expectations, which they called “second-order expectations”. In some cases, there is neither a clear asset A, nor clear sources of value S, nor a clear predictable future F. Nonetheless, there is a particular innovation field in which some actors propose to work with others with a view to making some assets (As), some sources of value (Ss) and some valuable future (Fs) emerge. In that sense, this proposal is a “second-order expectation”: it is the promise, or the expectation, of *creating* first-order expectations (i.e. anticipative, asset-based expectations). What is expected is the creation of the unexpected, or the ‘unexpectable’, at a certain moment when well-formed “first-order” expectations cannot be formulated yet. Strictly speaking, rather than generating a single stabilized deterministic link between assets As, sources of value Ss and one valuable future F, expectations tend to support the *emergence* of new assets (As), new sources of value (Ss) and new futures, Fs. Hence, such expectations should help design many possible futures! This is why we call our model a model of ***generative expectations management***. This means that in case of generative expectations an expectation F based on As and Ss will be so unknown that it is impossible to define $P(F/A)$ and $V(F/S)$. Generative expectations are asset-free and design-intensive, whereas anticipative expectations are asset-intensive and design-free.

When this kind of situation is managed in the same way as anticipative expectations, this tends to create hype and a technological speculative bubble. Initially, the expectation raiser might identify a credible A, credible source of value S, and a credible F, with an apparently high probability of reaching F on the basis of A to get high value on the basis of S (anticipative, first-order expectation). In this case, the logic of anticipative expectation does not lead to the exploration of a variety of As, Ss and Fs, but will tend to *reduce* explorations around A, S and F. In anticipative expectations, the link from assets (A) and sources of value (S) to expected future (F) is ideally deterministic, design-free.

Hence, when second-order expectations are managed in the same way as first order expectations, they are formulated to attract investors and tend to be “low-hanging fruits” for non-designers who will ask for simple “first-order” expectations, reinforcing the drift. Moreover, since second-order expectations are related to radical situations of systems innovation with high levels of uncertainty and unknownness, disappointment is very likely to follow on from the hype surrounding “A, S→F”. This explains why, in cases of higher uncertainties, this kind of expectation provokes cycles of promises and requirements, as explained in Geels and Raven (2006), Van Lente (1993) and Van Lente and Rip (1998)) and leads to emerging irreversibilities, as explained in Robinson and Propp (2008b).

One can note that the bubble is not caused by a distance between belief and reality (as is the case for classical financial bubbles) but by a distance between the belief and the outcomes of the design process. This is not even an overestimation of the design process (we thought we could get F but finally we can’t) but a misunderstanding (or an underestimation) of its real generative

potential (the design process is non linear, expanding, and it generates future that couldn't be anticipated at the beginning – ie that could not be “taken in advance”).

To conclude, when second-order (generative) expectations are managed as anticipative ones, they tend to create fragile collaborations, with non-relevant stakeholders, or even non-designers, resulting in cycles with slow or even no convergence.

2.3. Research questions

We can now clarify our research questions relating to the management of generative expectations, in contrast to the management of these expectations in a “rational expectation mode”. Is there another model? What features might it have? What are the relevant questions to address?

- Q1: The process of generative expectations management. What are initial generative expectations and how do they evolve over time? In particular we wonder how expectation managers avoid hype and disappointment and long, repeated and poorly convergent cycles.
- Q2: The partners. Who are the relevant partners in cases of generative expectations? What do they expect from the “promise” resulting from their collaboration? In second-order expectations, the notion of “realisation” has no clear meaning since, strictly speaking, there is no clear capacity to realise. Hence, who are the “relevant” partners becomes: what are their interests and how can they be involved in the process?
- Q3: Principles of cohesion. What are the principles of cohesion in cases of generative expectation management? In the absence of a clear valuable future that would echoed a clear robust set of initial assets, the cohesion cannot be based on a sharing of the value of the future, which is uncertain, nor on the costs of it, which is already distributed in property assets, On what can it then be based?

By answering these questions, we expect to clarify some aspects of generative expectations management.

3. RESEARCH METHODOLOGY AND EMPIRICAL DOMAIN

3.1. Case study methodology

Given the limited theory and the goal of exploring organisational phenomena in a new context, we adopted an exploratory approach based on grounded theory-building (Glaser and Strauss 1967; Eisenhardt 1989; David and Hatchuel 2007) and a practice based approach of transformations in agriculture and agricultural R&D (Barbier and Lemery, 2000; Barbier, Cerf and Barrier 2005).

The research method was an inductive, in-depth case study of hemp production and the quest to increase the commercial value of natural fibres. Around 50 interviews were held and analysed with Computer Assisted Qualitative Data Analysis Software and Network Analysis Software (Caron and Barbier, 2009). Two longitudinal case studies were also carried out. Comprehensive meetings were organised with the actors during the research process to improve the robustness of our grounded hypothesis and to discuss their specific stakes.

The empirical study shed light on a revealing case of collaborative design in an emerging industry on the subject of “building with hemp” in France, in the context of the growing interest and value given to sustainable development (Garnier et al. 2007). Despite the fact that single case study methods make general empirical validation impossible, they can nonetheless reveal interesting phenomena, provide opportunities for learning (Siggelkow 2007) and help to propose new models of collective action (David and Hatchuel 2007).

3.2. Empirical domain

This case study is interesting since it does not follow the usual patterns of the dynamics of emerging industries. Even though the core design “team” was composed of small actors, they were able to organise an industry architecture with the majors of the cement and concrete industry (contrary to the classical model in which the incumbent leads the industry architecture or the situation of new entrants as lone entrepreneurs (Ferraro and Gurses 2009)). Even though many hemp producers, material providers, architects and masons were not convinced by the new architecture and could have opposed the new rules, they all participated or at least “went with the flow” without blocking it, as they would have done with a traditional standards committee (Morris and Ferguson 1993). Even though some companies possessed critical assets in the projected industry architecture, they did not freeze the process in a single direction and kept up the broader collaboration (Teece 1986; Jacobides, Knudsen and Augier 2006). This is largely explained by the fact that they all shared expectations for the future of hemp building and that these expectations went beyond their direct (positive or negative) interests.

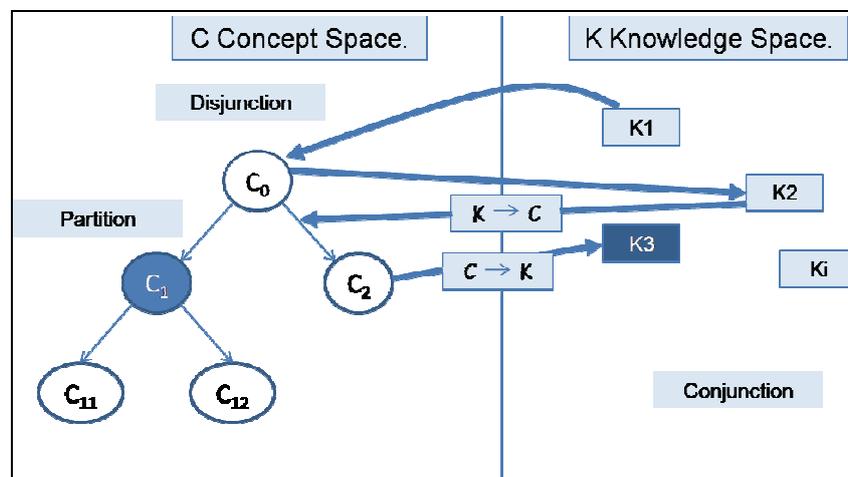
3.3. Interpretative analysis of data

K.M. Eisenhart, with many other authors of organisation studies, suggested that a set of different methods has to be used to “triangulate” results; in this study, discussion seminars and documentary analysis were used as a complement to the interviews. Using the reference framework proposed by (Geels and Raven 2006) we rigorously followed the evolutions of expectations, learning and networks over time. Building on the works on multi-path mapping (Robinson and Propp 2008b), we analysed the *various* expectations of the actors over time through the detailed study of settings, significant events or pathways, and narratives as

proposed by innovation studies (Callon and Law, 1992; Deuten and Rip, 2000) and their application to sustainable innovation in agriculture (Barbier 2008). This retrospective account was organised in what can be called a map of the “value landscape” (Thomke, Von Hippel and Franke 1998; Levinthal and Warglien 1999; Baldwin and Clark 2000). It consisted in *mapping all the identified potential futures* envisaged by the main actors with their related value proposal.

One critical issue in our work was the ability to follow the design of new visions and promises. For these purposes, we used the most recent models of design reasoning (C-K theory) (Hatchuel and Weil 2003), which generalise classic engineering design models (Pahl and Beitz 2006) and search models (Simon 1969; Hatchuel 2002). *C-K theory* describes design reasoning as the interaction between two spaces, the concept space (called C) and the knowledge space (called K). Design begins with an initial concept, a proposition that is neither true nor false, i.e. that is undecidable in terms of evidence-based knowledge: we call this separation, a disjunction). In design briefs of this sort, it is impossible to say whether or not the concept is feasible, marketable, and scientifically grounded. For instance, “building with hemp” was already a concept in the 1990s. The design process consists in refining and expanding the concept by adding attributes from the knowledge space (hemp raised issues on water absorption for instance). The process can also lead to the production of new knowledge to be used in the design process (e.g. new criteria and new test bench for hemp concrete, hence mobilising evidences from scientific and technological experiments). The initial concept set is partitioned step by step into several, more refined, subsets. The process unfolds until one refined concept is sufficiently specified to be considered as true by the designer, at which stage the concept becomes a piece of knowledge: we call this coupling, a conjunction). This often means that the concept becomes a manufacturable, marketable product when the conjunction corresponds to commercial products. The generic structure of this design reasoning is presented in Figure 1 below taken from Hatchuel and Weil (2009).

Figure 1. The generic pattern of design reasoning in C-K design theory



The C-K framework helped to encode the set of stylised facts derived from interviews and to enable a complete picture that accounts for the collective and cognitive processes that shape expectation management. We tracked the expansion of the knowledge space and that of the conceptual brief into several varied alternatives. When data was missing or links between C and K were unclear, we went back to our data and if needed to the actors in order to obtain more information (to complete with new data, to confirm shortcuts in collective reasoning, etc.). In this sense, this very general, abstract framework helped to control the consistency of our analysis. The detailed picture of the process under study helped to identify the pieces of knowledge used in the organisation to incrementally develop new products (including strategy, organisations and mental models). These were the design rules, i.e. the routines of action used for incremental innovation. We were able to identify three important types of behaviours: (1) whether designers in radical innovation situations make use of existing design rules (Baldwin and Clark 2000; Baldwin and Clark 2006) or create new ones, (2) how designers are able to define missing knowledge characteristics (from C to new K) and (3) how it results in the production of new knowledge (from K to new K). This method helped us to rigorously identify the competencies used and created throughout the process, and the various paths followed for the different industry architecture alternatives that emerged during the process.

In parallel to, and based on this cognitive perspective, we also analysed relational phenomena by identifying the relevant actors, the types of relations between them, and the structures and activities of organisations. In particular, we followed the type of actions and decisions they faced at critical moments in the history of “building with hemp”. Such analytical framework can be found in different works initially promoted by Science and Technology Studies (Latour, 1987; Callon, 1991; Callon et al., 1992; Law and Callon, 1992) or Longitudinal analysis of case studies in Organisation theory (Van de Ven and Poole, 1990; Pettigrew, 1990). We followed the same perspective with one specific improvement: we paid a great attention to the logical status of the propositions held by the actors. As justified above, the study of expectations requires to clarifying whether the proposition relates to the “known” (the proposition is considered as either true or false) or to the “unknown” (the proposition has still no logical status).

This distinction is particularly critical in the study of expectations:

for any given proposition on the expected future F, when this proposition is considered as knowledge (in K space in C-K theory) then it tends to raise anticipative expectations, people pay attention to the consequences of the proposition and wonder whether they have an interest in these consequences;

conversely if a proposition on the future F is considered as a concept (in C space), then it calls for knowledge and further concept expansions to explore beyond the concept. People pay attention to the expansions that could be stimulated (suggested) by the concept.

Recent studies related to issues in creativity in Management Sciences have led to use such a method, where one pays attention to the patterns and momentum of

critical pathways in creative organisations based on the C or K status of the propositions (Ben Mahmoud-Jouini, Charue-Duboc and Fourcade 2006; Elmquist and Le Masson 2009; Gillier et al. 2010; Hatchuel et al., 2006; Hatchuel et al. 2010). Our methodological device tries to articulate these two phylums of thought, particularly requested to address sustainable transition issues that convoke inter-organisational dynamics (Barbier, 1998; Aggeri, 1999).

4. CASE STUDY ANALYSIS: SMART EXPECTATION MANAGEMENT IN “BUILDING WITH HEMP”

The cooperative “La Chanvrière de l’Aube” (hereafter called LCDA) transforms raw hemp into by-products (fibre, hemp chaff, fruit, oil, etc.) with commercial value. Historically, only the hemp fibre, which was sold to cigarette paper manufacturers, was really profitable. However, this business decreased steadily from the beginning of the 1980s and LCDA tried to find new value for hemp products by exploring new uses. We studied the history of one of these explorations – building with hemp – from its beginning in 1986 until 2008, focusing on how LCDA employees were able to manage expectations and finally create a new industry.

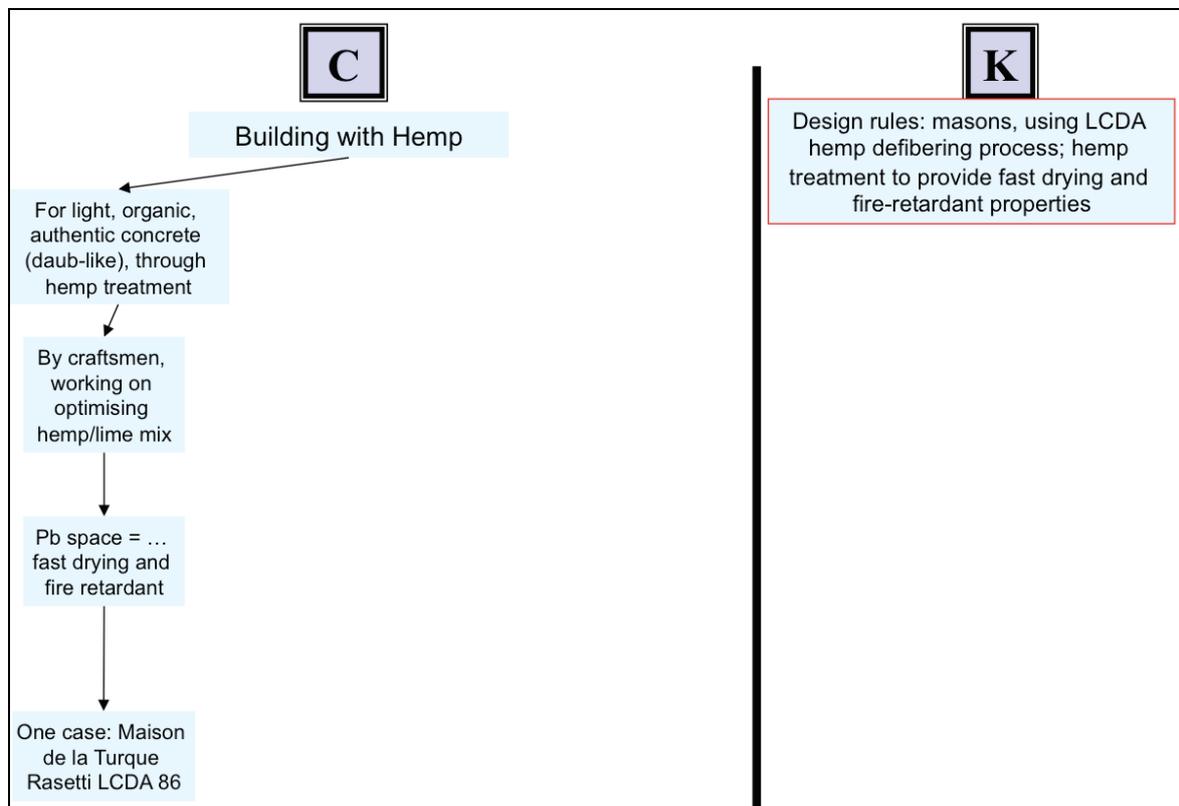
From the collected data, we can clearly distinguish three milestones in the history of the exploration, each of which is structured around a meeting of the stakeholders in “building with hemp”. Phase 0: the reference situation, without “expectation management” (1986-1993); Phase 1: raising expectations by designing (and expanding) the innovation field (1993-1998), the first meeting taking place in 1997; Phase 2: developing the first templates of an industry architecture by broadening the innovation field (1998-2005), the second meeting taking place in 2001; and Phase 3: business growth by maintaining the exploration effort (2005-...) with the third meeting taking place in 2006.

4.1. Phase 0: innovation by means of local experiments (1986-1993)

In 1986, Mr. Rasetti, a mason, asked LCDA to supply him with some hemp chaff for building purposes. With Mr. Rasetti, LCDA developed an aggregate of hemp chaff for light cement, Canobiote ®. Competitive products were also launched (Isochanvre®, Canosmose ®). In the following years, LCDA provided several masons with hemp chaff, which they used in cement. The cooperative realised that these entrepreneurs were carrying out technical trials to combine lime with the hemp in order to obtain a daub-like concrete. However, the trials were relatively unsuccessful as there was little market growth and no reliable solutions were found to use hemp in construction. Nonetheless, several applications had been identified by the masons (light concrete, substitution, historical restorations, etc.). One example at that time was the restoration of the *Maison de la Turquie* in Nogent sur Seine. As its properties are close to those of daub, the

historians and architects involved in the project considered that hemp cement was an appropriate material for the restoration.

Figure 2: Design reasoning on hemp building (1986-1993)



In this initial phase, from 1986 to 1993, the hemp transformer and all the masons followed one main design rule: *the integration of hemp into cement will be obtained through a treatment of the hemp fibres*. The knowledge regarding cement, construction and lime was limited, as confirmed by the actors at the time. The use of this design rule was determined by LCDA's strategy, whereby construction was merely an opportunity to sell the products derived from an investment in a new defibering process. LCDA also wanted to be independent from cement makers and to avoid any impact on the recent investment in a hemp defibering process. It expected a technical solution to be provided by the customers (i.e. the masons). This was coherent with their organisation, as LCDA's limited resources were devoted to meeting the demands made by the customers of the new defibering process (and not to developing a new hemp-based solution). As a consequence, LCDA kept constant contact with a network of masons who needed hemp by-products for their concrete. It was aware of all the experiments on cement-with-hemp and made marginal adjustments to its defibering process, based on the knowledge acquired from the masons.

Hence, expectations were limited and "building with hemp" was associated with one narrow concept, i.e. hemp for renovation, for light organic, daub-like concrete, for masons, etc. (see Figure 2). Secondly, expectations were not managed at a collective level. Cooperation was limited to an emerging network,

based on informal, reciprocal recommendations between a group of masons and LCDA. Knowledge production was restricted to experiments on fibre treatments. As a result, actors in the field were confronted with decisions such as whether or not to “buy hemp aggregate” or “fund this hemp aggregate company”.

4.2. Phase 1: Raising expectations by expanding the innovation field (1993-1998)

In 1993, LCDA decided to invest more heavily in the creation of new applications for hemp, in particular in construction, “*because of several years of very low growth*” (to quote BB, head of new applications for hemp in building at LCDA):

“[W]e had the intuition that the initial path was too narrow and that we should find new alternatives, not necessarily based on hemp treatments for special masonry.”

Previous experiments had mainly resulted in unsuccessful trials and difficulties in addressing problems such as the choice of the binder, the type of cementing process, etc. LCDA decided to embark on a rule-breaking phase based on more ambitious objectives. In this perspective, BB started to contact lime producers and managed to launch a development programme with one of them, on a new tack coat. It was officially launched in 1997 and a trademark, “tradical 70” ®, was registered. He also got in touch with new actors – architects, materials scientists – to convince them to work on hemp. For instance, a public research programme was launched jointly by LCDA and ENTPE (an engineering school specialised in construction techniques) on hemp cement characterisation (thermal, acoustic and mechanical properties). From then on, network building continued, but in a different direction.

At the end of 1997, LCDA organised a workshop with a wide attendance base (all the hemp builders at the time), to clarify the potential of “building with hemp”. Several experts made presentations on previously unknown aspects of building with hemp, revealing the limits of past experiments. The meeting was an interesting way of providing new knowledge to change mental models and imagine potential collective strategies.

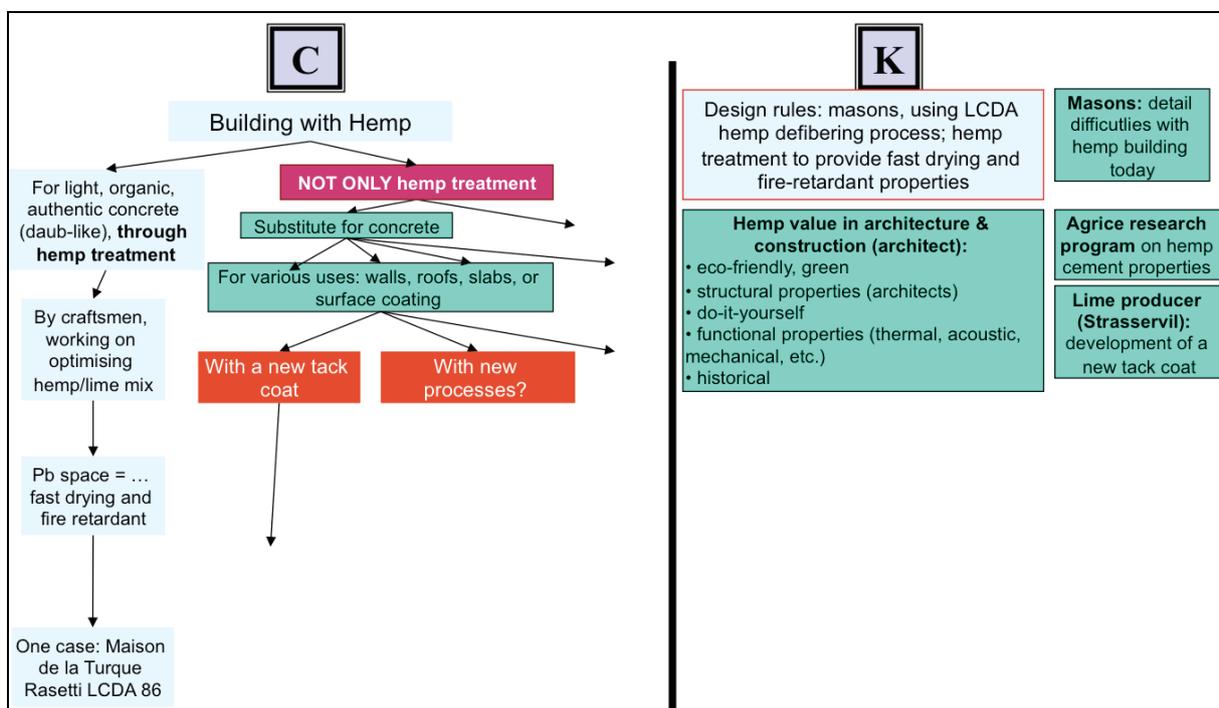
We must underline the very specific knowledge and understanding produced at this meeting. The C-K diagram below (Figure 3) represents a simplified version of the cognitive dimensions of the innovation field that participants discovered during the meeting. To raise expectations, LCDA did not provide one specific promise but set the provisional frontiers of an expanded innovation field, opening new paths with several pending questions. New pieces of emerging knowledge were also assembled by means of the presentations made by researchers, architects, masons, etc. These preliminary results opened more questions than they provided answers. As LG, a mason-entrepreneur explained:

“We had a roundtable discussion where everybody explained how they had experimented with hemp building and that there were no problems. When it

came to my turn, I said: 'I don't understand, you all build with hemp but nobody has mentioned the problems. I have problems, for example that the mortar doesn't dry, I don't know how to mix it, I don't know how to fix it on the wall, the setting is uncertain, etc.' Then we went round the table again and it became clear that we all had the same problems."

Hence, the meeting helped to *raise and share new expectations* and made people aware of the *absence of any reliable techniques*. It could be said that LCDA raised expectations at this meeting, not by validating the technique but by expanding the innovation field to new alternatives. It reinforced the logic of generative expectations.

Figure 3: Raising expectations by structuring the innovation field (1993-1998)



During this meeting, LCDA confronted the participants with a simple decision: whether or not it was worthwhile for them to take part in the "hemp building movement". Rather than having to decide to "buy" or "fund" a business, they had to decide whether or not to commit to an open design process. The decision tree was based on the innovation field described above; it did not show particularly good "first-order" expectations. The emerging industry might show high or low (or even negative) profits in the future, and the meeting had clarified that: 1) there were different alternatives for the future and that 2) none of these alternatives had high or clearly identified probabilities, and all of them were at least partially unknown (and some were almost completely unknown).

This is therefore a case of smart expectation management based on:

- Increased expectations concerning the innovation field, illustrated by the creation of many valuable, high-level alternatives. By correctly managing the

options, LCDA and its partners increased the variety of alternatives, not the means of their success.

- No explicit solution. However counterintuitive this may seem, contrary to classical business plans and fundraising processes, neither credible technical solutions nor clear project management solutions were presented. On the contrary, the meeting underlined the participants' ignorance! However, it helped to identify "shared uncertainties" (Aggeri, 1999) as well as the potential contributions that each participant could provide to the others. This process of identifying shared uncertainties was important as it helped to avoid building up too much hype. It also enabled the commitment of designers and not only funders.
- The action consisted in deciding to "design" or "not to design" with LCDA and its partners, and not to "fund" or "not fund". This decision-making situation led to the selection of *design contributors* as stakeholders (see appendix for more details on the structure of the set of decisions that LCDA was able to design to "select" design contributors)

As a consequence, this first phase ended in 1998 with the creation of a new collective actor, in the form of an association for building with hemp, designed to act as a research and innovation platform for all the participants. The association was created with a stable legal status and an initial mandate from the participants. A governance structure was defined with a *core team of founding members* (hemp transformers, lime producers, material researchers, architects, entrepreneurs, masons), all of whom had relationships with LCDA.

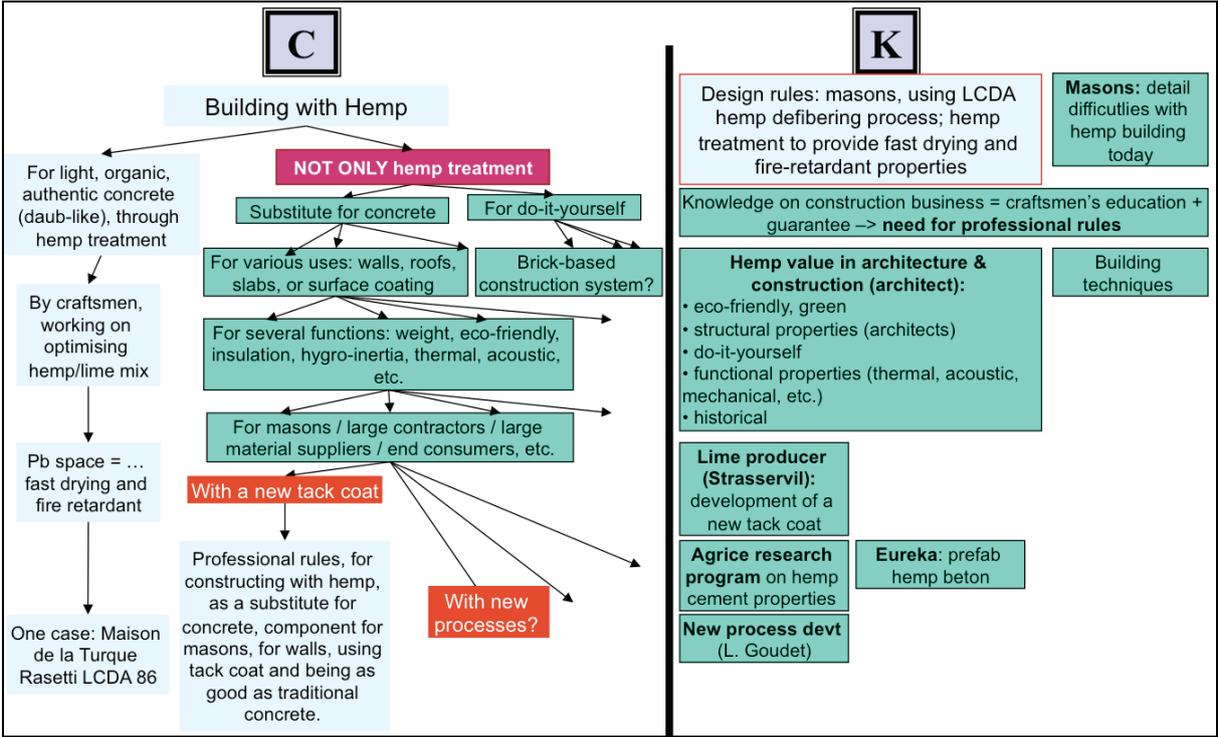
4.3. Phase 2: Developing the first templates of an industry architecture by broadening the innovation field (1997-2005)

After the creation of the "building with hemp" association, the participants started to explore new paths and design complementary experiments. LCDA and Strasservil developed their new tack coat. Research labs started to work on hemp cement properties. Entrepreneurs developed and experimented on their own different processes. Masons worked on how to use hemp concrete in several geographical locations and for various different uses. The core team met every two months between 1998 and 2000 to set in place the association's status, organisation, projects and strategy. In parallel, new members joined the association, in particular the institute in charge of controlling hemp production (FNPC/CCPSC)⁴. During this period, promises began to be converted into products, services and quality criteria. The process of path creation was nevertheless maintained and several processes were explored for building with hemp. New forms of business were discussed, such as selling hemp concrete

⁴ The strains of cannabis approved for industrial hemp production produce only minute amounts of psycho-active drug (Δ^9 -tetrahydrocannabinol (THC)) and certainly not enough for any physical or psychological effects. However, trade in hemp grain and hemp production are severely controlled. Very few countries currently authorise hemp production (France, China, Canada).

building blocks with a complete construction “system”. New properties for hemp concrete were also investigated, demonstrating that hemp concrete was not only a “sustainable product, as good as traditional concrete” but that it also had breakthrough properties. As a porous system, hemp concrete enables new types of air circulation in buildings; as a water-absorbing product, it can help regulate humidity; and it can also offer new forms of acoustic comfort.

Figure 4: Developing the first templates of industry architecture by broadening the innovation field (1997-2005)



It became increasingly clear that it was indispensable to organise the industry because robust construction businesses must obtain decennial liability coverage from insurance companies and this requires stable, standardised, validated materials (hemp, lime, aggregates, etc.) as well as routinised practices, implemented by masons qualified to use hemp. The rule-making process consisted in drafting a set of “professional rules”. The building profession validated these rules as the “good practices” to be followed to obtain decennial liability insurance. To write these rules, the actors had to select (and validate) some types of products (and hence exclude others) and select (and validate) some practices (and exclude others) to finally stabilise a division of labour (between hemp producers, hemp transformers, lime producers, aggregate producers, masons, architects, etc.) and, unavoidably, the division of value. Professional rules emerged as one way to support business development in building with hemp, but their design automatically meant that potential “winners” and “losers” were identified. This happened at a critical moment when a stable industry architecture was required (i.e. with templates for the division of

labour and value) (Jacobides, Knudsen and Augier 2006) but introduced the risk of conflicts of interests.

The second major meeting on “building with hemp” took place in this context in 2001. 250 people took part, far more than at the first one. In particular, new construction firms and institutions attended the conference (craftsmen, the French Federation of Building (FFB), CSTB (Scientific and Technical Centre for Building), ADEME (French Environment and Energy Management Agency). The participants were informed of the progress made since the last meeting and gradually became familiar with the innovation field as a whole. They also became aware of future issues regarding the professional rules: how could they be developed and taught? What could be done to spread their use?

Interestingly, the focus of the conference was *not* on the professional rules. Participants were simply asked whether or not they would go on building with hemp. As a consequence, the expectations encompassed the whole innovation field, beyond the professional rules. This framework had interesting effects on the stakeholders’ commitment. Let us analyse three critical cases:

Potential free riders: one risk in stabilising industry architecture is the emergence of so-called “complementary assets” (Teece 1986; Jacobides, Knudsen and Augier 2006). Owners of complementary assets avoid paying the cost of innovation development although they know they are certain to benefit from it. If a complementary asset owner has to choose whether or not to commit to the development of professional rules, the expectation of utility is greater for the negative response since the revenues and probabilities are the same whatever the choice, but the costs are lower in the case of refusal. In the case of building with hemp, when owners of complementary assets for professional rules had to choose between “go” or “no go” (in committing to the broad “building with hemp” innovation field), they were likely to choose to participate since:

- the innovation field made it clear that there were still many different types of professional rules, so that the complementary asset was not certain;
- the innovation field also made it clear that the professional rules were not the only path and that other paths remained open. For instance, some of the actors interviewed were concerned by the fact that the adoption of professional rules should not be the only option and that other trajectories such as building blocks for the “do-it-yourself” market would still be possible.

Stakeholders hostile to professional rules: another risk in stabilising industry architecture is the emergence of conflicts of interests. As long as the details of the promise remain unknown, the economic consequences and conflicts of interests are unclear. With stabilised industry architecture, the benefits and losses are more easily evaluated. If a potential loser had to choose whether or not to commit to developing professional rules, he would refuse and might even fight the project. However, with the choice of taking part in building with hemp, he was likely to go ahead since:

- the professional rules were still unknown, potentially leaving some degree of freedom for obtaining value from one of their future versions;
- he may have been in a stronger position for the design of other businesses in the “building with hemp” innovation field.

The members interested in the professional rules followed their logic of action and went on developing knowledge to meet the rules’ requirements. They were in a favourable position for developing such rules, since their experience in the context of “building with hemp” encouraged them to share knowledge and identify missing knowledge to meet the requirements. The association attracted competent, relevant members, who provided knowledge on the process of creating new professional rules. Moreover, some members of the association took part in the process of validating the professional rules. For instance, the French Building Federation distributed the first versions of the professional rules to its members for criticism and comments.

Hence, the potential contradictions were moderated by an interesting rule according to which members of associations may or may not participate in the professional rule-making process. Those interested in the standardisation of processes opted to work on professional rules; the opponents refused to become involved but still remained members of the association. We must underline that this means that the association had configured two *separate types of decisions*: the stakeholders had to decide to be members of the association; on the other hand, some members had to decide whether to take part in the “professional rule” project. This flexibility and openness encouraged participation in the “building with hemp” association, which continued to expand after 2001. It also produced a paradoxical result: the association launched the professional rule project even though opponents of the project were members of the association. Initially organised as an informal initiative, encouraging results convinced partners in the professional rule group to turn this into a formal project in 2004. The first draft rules were established in early 2007. New research projects were also launched during that period, in particular one launched in 2004 to study prefabricated hemp concrete building blocks with associated systems design principles.

4.4. Phase 3: Business growth by maintaining the exploration effort (2005- 2009)

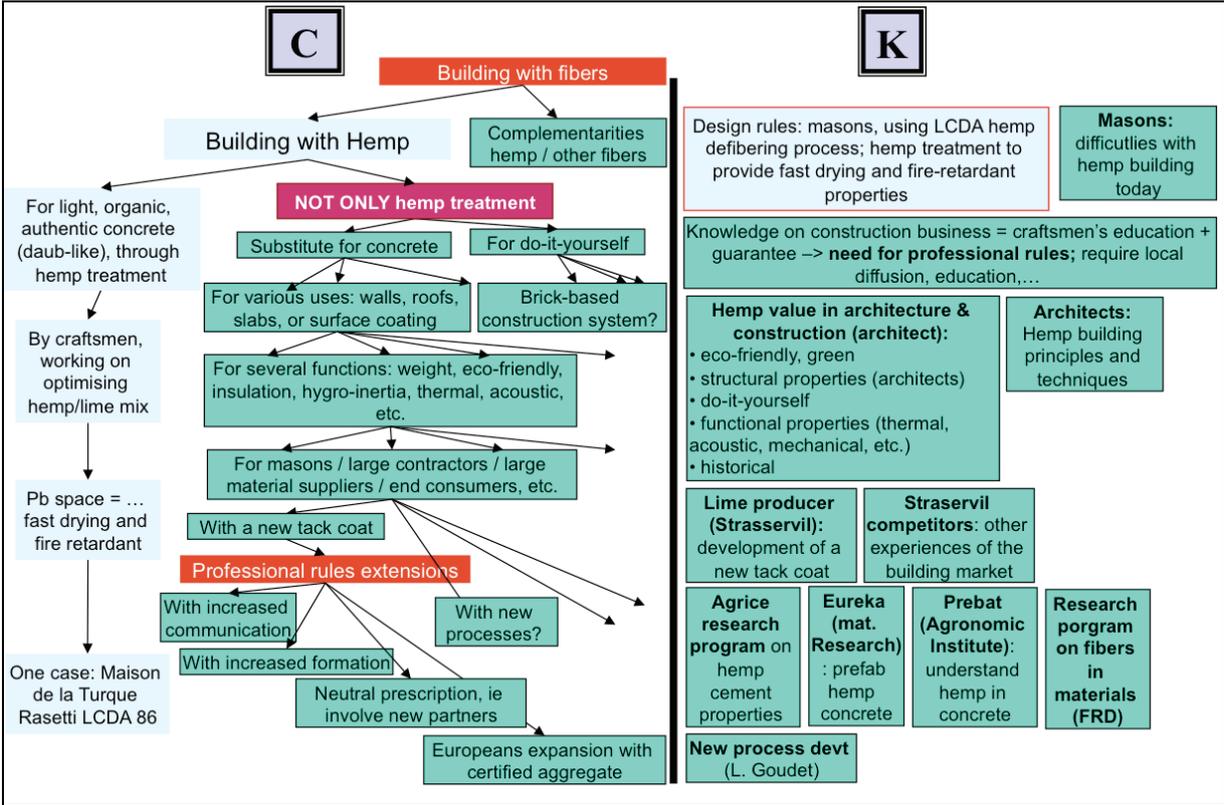
In 2005, the professional rule-making process had reached convergence and templates were about to be set. At the same time, expectations were rising and with them, greater risks of disappointment. In the context of the French presidential election campaign (2006-2007), the left-wing candidate promoted hemp as a sustainable development material for eco-building, which also raised stakeholders’ expectations.

During this period, LCDA and its partners followed two main paths in terms of the design process. On the one hand, following on from the professional rules project, they began to design related services, e.g. information on the professional rules;

education and training for masons, based on the rules; generalisation of the rules in the European Union; increased standardisation, etc. One striking action consisted in involving new partners from the construction materials business. The “building with hemp” association contacted the competitors at Strasservil (at the time called Lhoist-BCB) and global firms such as Lafarge, Calcia and other concrete, lime and cement producers. These new partners provided their experience of the construction market and gave increased legitimacy to the association, which could no longer be viewed as an agent for one particular lime producer. In research, the new national Prebat research programme (on energy efficient construction) allowed agronomic researchers to gain a better understanding of hemp in concrete.

On the other hand, new exploratory initiatives were prolonged or launched: a European Eureka programme continued to study construction principles and building blocks for hemp concrete; at the same time, alternative properties were explored for building with hemp (acoustics, hygrometric comfort, etc.); and connections with other fibres were put on the research agenda, for instance by studying complementarities in hemp, straw and wood.

Figure 5: Business growth by maintaining the exploration effort (2005-2010)



In this context, a special effort was made to structure the set of potential decisions. The third meeting on “building with hemp” took place in 2006. This time, it was a major event and hemp was clearly recognised as a matter of national interest. Instead of taking place at LCDA’s premises in Bar-sur-Aube, near Troyes (Champagne region), it was held at the Ministry for the Environment

in Paris under the patronage of national representatives. This decision demonstrated the state's support for the association and also meant that several other public administrations and agencies could take part, as representatives from the Ministry of Infrastructure and the Ministry of Agriculture, standardisation agencies and social housing agencies also attended. Why did hemp attract political interest at that time? The major reason was that building with hemp had been recognised as a potential path for addressing issues of sustainability in the construction sector. Over the years, this issue had gradually emerged and had, by this stage, become a major driving force for the development of the nascent industry. These stakeholders were not only a powerful reference for the association, offering valuable support for the public recognition of the professional rules, but also potential partners and funders for new explorations.

From the point of view of LCDA and its partners, the “expectation managers”, this event was a great opportunity. Yet, they were concerned about the risk of it creating bubbles of hype and expectations that the actors would not be able to meet. The sustainable development “fashion” might fade, and/or the expectations surrounding the professional rules might be disappointed for large-scale construction. It should be said that hemp was only grown on a total surface area of 10,000 hectares in France, mostly located, like LCDA, in the Champagne region. Confronted with the growing fad for building with hemp, the head of LCDA, Benoit Savourat, tamed expectations in an interview in the newspaper *Ouest-France* in July 2009, by stressing that there were still many uncertainties in the business and many unknown factors to be dealt with. He underlined the fact that large-scale industrial and commercial applications were still far off and that more R&D would be required before a reliable industry architecture could be achieved. LCDA and its partners were nevertheless still interested in expectations design but they hoped that expectations would attract relevant stakeholders, i.e. potential partners to reinforce the network rather than create disturbance. In this perspective, new stakeholders were approached to launch a collaborative research programme on fibres – rather than hemp alone – with applications for building, and on other composite materials.

5. MAIN RESULTS AND IMPLICATIONS FOR INNOVATION GOVERNANCE: EXPECTATION MANAGEMENT AND THE LOGIC OF THE COMMONS

The story is still in the making. Rising expectations are moving in tandem with continuous growth. More farmers have started to cultivate hemp and large investments have been made to develop industrial hemp processes. How far can this innovation lead? To what extent can building with hemp emerge as a credible competitor to concrete, wood or other natural fibre systems (such as straw balls) for sustainable construction? This is still an open question. An interesting evolution is that building with hemp has recently become an international issue with achievements and extensions of the industry's network in the UK, Germany

and the US, where certain states have decided to legalise the cultivation of industrial hemp again on the grounds of sustainability.

Based on this empirical study, we can now return to our research questions to formulate research proposals relating to generative expectation management and then to propose a new model of expectation management.

- R1: promises and realisations co-evolve over time.

Contrary to the usual representations of first-order expectations and business development, instead of the creation of an initial promise *followed* by the realisation of this promise, we see a constant renewal and expansion of promises all along a series of developments. Generative expectations constantly create first-order expectations that are fulfilled on a regular basis of short-term incomes management. There is not just one “expansion” for one business project, but a dual expansion, one for business development(s) and one for a common technological imaginary muddled through time! This dual expansion is managed as a mutual feedback process in which new visions support realisations and vice-versa..

- R2: design commitment: expectation managers design to encourage the commitment of stakeholders who are designers and who expect to obtain better design resources from the collaboration.

Contrary to classical approaches to business development, expectation managers do not look for new business funding; they try to encourage commitment to design. They constantly encourage stakeholders who participate in the design process. One consequence is that, formally speaking, expectation management consists in avoiding the need for stakeholders to make decisions, in the strict sense of decision making under uncertainty, i.e. when the decision does not influence the future “states of nature”. Expectation managers tend to favour situations where the stakeholders are precisely those who are able to design, i.e. to create new states of nature!

- R3: the cohesion model can be analysed as the management of a new common good (Ostrom 1990), a common space for generative action.

The cohesion model of expectation management is not based on a pre-existing value to be shared between partners following a common logic of payback maximisation. Cohesion is based on the value of a shared “space” for generative action. The collaboration consists in developing shared value that increases the action capacity of each partner. This space follows a logic of “common good” management in the sense developed by Ostrom (Ostrom 1990). It is neither a private space (a private company competing against the others in an innovation field) nor a public space (a publicly supported innovation field) but a commonly owned one (several stakeholders in an innovation field collaborating to make it grow). Expectation managers are internal regulators of expectations: they keep up a constant momentum, “raising” and “decreasing” expectations to counteract the “hype cycle”.

6. CONCLUSION

We have contrasted two models of expectation management: rational expectation management versus generative expectation management. Rational expectation management is well-known. In cases of radical systems innovation, the literature has shown that expectations are necessary but that they are of a different nature, characterised as second-order or, as we propose, generative, i.e. that there is the expectation of creating a first-order, classical expectation. The literature has also underlined that using rational expectation management in cases of second-order expectations leads to fragile collaboration and repeated, slow and poorly convergent cycles of hype and disappointment. Based on the in-depth case study of building with hemp, we revealed a model for managing second-order expectations. This model is characterised by three features:

- The management aims to meet first-order expectations but it also constantly aims to create new first-order expectations and to renew and expand second-order expectations. This is not a process of transforming a promise into a reality, but one of dual (and complementary) expansions of promises and realisations.
- Instead of aiming to convince funders, generative expectation management aims to commit designers. It does so by designing new expansion areas for potential stakeholders.
- The cohesion is not based on an *ex ante* profit-sharing process relating to a valuable future, but on the management of a common space for generative action. The management of this common space consists in protecting it from external risks and in maintaining collective actions.

This research highlights a new logic for the governance of innovation at the level of innovation fields for emerging industries: *there may be a place, or even a need, for a new actor to manage the dynamics*. Beyond the management of R&D resources, IP rights and competences (which can be done by traditional firms, R&D labs, public regulators and socio professional groups), the role of this new actor in the governance of innovation consists in *managing the dual expansion of the second-order expectations (value landscape, the creation of new visions and new interests, etc.) and the realisation of first-order expectations (i.e. the realisation of visions for some interests)*. This new actor could be a private company (see Intel and platform leaders and all the cases studied by Gawer (Jacobides, Knudsen and Augier 2006; Gawer and Henderson 2007; Gawer and Cusumano 2008)); it could be a group of private companies (see our case study; plus innovative design consortia such as the International Roadmap for Semiconductors, ITRS - (Walsh 2004; Cogez, Le Masson and Weil 2010)); or this role could be played by public bodies such as the French clusters. This paves the way to further work on the activities and roles of this collective actor and the different organisational forms it could take in innovation fields.

This research also underlines the fact that generative expectation management is clearly based on innovative design activities, i.e. the capacity to create and refine

many possible futures. It suggests that efficient generative expectation management would benefit from tools and processes able to support innovative design processes, as shown by the pioneering work of Bram and Bos (Grin 2005; Bos and Grin 2008).

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CONCLUSION

Inducing change towards sustainable agriculture

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1. ROUTES FOR CHANGE

Before turning to the main findings from the papers, let us repeat some starting points from the introduction.

To tackle the problems of modern agriculture, two broad visions have emerged. In the first, based on the Knowledge-Based Bio-Economy (KBBE) paradigm, Life Sciences for techno-scientific development should provide the means to use renewable resources more efficiently. In the second vision, based on the Agricultural Knowledge Systems (AKS) paradigm, the way forward is to develop co-research relationships among all relevant knowledge-producers, including farmers.

The first paradigm is by far the dominant one. Although this is likely to lead to sustainability gains, it potentially turns agriculture (further) into a factory-like undertaking using capital-intensive inputs, while effectively marginalising farmers' knowledge and innovations. This may lead to a variety of new problems in connection with new ownership relations, new health hazards because of new micro-organisms or new routes for the spread of such organisms, changing North-South relationships, etc.

For these reasons, and also not 'to bet on one horse only', wise policy would be to put more emphasis on the AKS paradigm. This means that there should be more support for research programmes, projects and sector initiatives based on such approaches.

The differences between the KBBE and KBS paradigms reflect a distinction between two different patterns of innovation. The first relies heavily on technical

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change whereas in the second, organisational and institutional changes have also a large part to play. In innovation research these two different patterns are known as system optimisation and system innovation. A significant difference between these two paradigms is that system optimisation produces results more quickly while system innovation has a much larger problem-solving potential but takes longer to yield results. It is also more difficult to govern and there is still a considerable lack of knowledge on how to do this.

To tackle the challenges of modern agriculture most emphasis is on system optimisation whereas the nature of these challenges would require a system innovation. To achieve near-term results it may indeed be wise to take the optimisation route but to work towards an integrally sustainable agriculture in the longer term, with efforts aimed at system innovation also being made here and now. This is where the largest challenge lies and, to support this, the workshop focused on system innovation.

Historical studies on system innovation show that radically new developments initially meet resistance from an existing system. The so-called multi-level perspective (MLP) has proven to be a useful tool to analyse such dynamics. In the MLP, the meso-level of 'socio-technical regime' refers to the system of interest (e.g. the animal production regime). The macro-level of 'socio-technical landscape' relates to broader factors that may exert pressure on a variety of regimes for change, e.g. the pressure to curb CO₂ emissions. At the micro-level we find 'technological niches', a breeding ground for alternatives to an existing system. Initially these niches do not fit the system (e.g. because the alternative is too expensive, creates new problems, etc.) but through development in the niche the actors involved learn about how it can be made to work. Eventually, such niche developments may link up to the regime (i.e. the existing system) and gradually start to transform it.

2. INTELLIGENCE FOR CHANGE

On the basis of this model there are two crucial processes: (1) learning on radical innovation in niches and (2) the linking of niches to the regime and the resulting transformation process. The chapters of the present proceedings are discussed below in two sections corresponding to these two processes.

Learning in niche development

Focusing on niche development, the following three processes can be distinguished:

- **Network building:** the establishment of social networks with the necessary stakeholders.

- **Learning processes:** the actors involved learn about how they can make the novelty work, not only in technical terms but also by fostering relations with a variety of key stakeholders in order to develop and promote their activities, e.g. to develop markets for their products.
- **Alignment:** the development and alignment of strategies and expectations between involved actors. A variety of different stakeholders have to tune their efforts in order to make a new development work in practice.

Network building requires that actors from various backgrounds become engaged in the process, e.g. farmers, other stakeholders, researchers. These actors can have very different views on the direction in which to move. A project leader or facilitator will then have a very difficult task. One of the papers suggests that the facilitator can choose one of two different attitudes to carry out this task: (1) a responsive, serviceable attitude, through which the facilitator seeks to connect with participants and be responsive to their needs and wishes (the 'learning approach'), and (2) an attitude of leadership, through which the facilitator decides more or less unilaterally on how to move forward (the 'leading approach'). The approach taken usually depends upon the facilitator's character.

Each of these approaches has its pros and cons, and the most successful attitude usually contains elements of both, applied according to the situation at hand. The general lesson is that stakeholder management is a critical success factor but this is insufficiently acknowledged in current policies and strategies. The lesson for governance is that policy makers should promote procedures such as stakeholder management, along with 'traditional' instruments like taxes, incentives, etc. The key issue to be addressed in further work (i.e. in research as well as projects) is how to find the right balance in using these different instruments in various specific circumstances.

System innovation projects in niches typically start with great ambitions, i.e. to explore radically different alternatives to the existing system. Experience shows that because of resistance and scepticism encountered from the prevailing regime, project developments tend to move closer towards the incumbent system and lose some (or much) of the original innovative ambitions. A monitoring and evaluation scheme can then be instrumental in supporting project managers and innovation networks to keep the ambition high by stimulating reflection on project goals, activities and results in light of developments in the project and in the existing system. The lesson for governance and funders is that they should require project managers to set up a monitoring and evaluation scheme to help them keep their innovative ambition.

Governance of innovation for sustainability typically focuses on organised projects as the way to learn about possible alternatives to an existing system. This 'top-down' process is indeed important but it neglects another, bottom-up process through which a broad variety of stakeholders in practice also try to develop new solutions to the challenges that they encounter. Such activities usually are not encouraged or taken up by the incumbent regime, the

stakeholders, or policy makers. As a result, a lot of 'local learning' is lost. What is missing is a general attitude of wanting to learn from what has been learned elsewhere. There are many such networks around a variety of solutions, but little clarity on which ones will eventually prevail. A robust policy should then promote diversity instead of promoting individual niches. Furthermore, the assessment of what has been learned should combine results from organised projects (top-down) and results from learning by practitioners (bottom-up).

Linking niches and regime: towards necessary changes

Learning in niches is crucial to an exploration of how a variety of agricultural practices can be made more sustainable in various dimensions. Eventually, however, learning is only one step in changing these practices on a larger scale. In terms of the MLP this means that niche developments have to be linked to regime developments. This, of course, results in transformation processes that clearly challenge "business as usual".

Several of the papers discussed showed that to increase the chances of successful linking it is important to engage a variety of stakeholders, including farmers, consumers and NGOs. At first this may seem to complicate things and often it does. A critical step in this direction is to build trust among stakeholders. The importance of this may seem trivial but in practice it is often overlooked in projects and change processes. If trust is lacking, actors may talk at length about issues of content but they will never find the common ground that allows them to move forward. Building trust is critical in the initial stages of a change process and should receive all the attention it warrants.

Transforming a socio-technical regime is a long-term process. This process is much more complicated than the diffusion process described by classical, linear innovation models. In a transition, initially small parts of a regime start to change. With further growth, new actors become involved, which leads to further changes and adaptations. These often require an additional step in a learning process. The result is a process of gradual transformation and it may take a long time before the novelty is able to survive without external support. This implies that governing transitions should also last a long time, providing various types of support, depending upon the issues at stake. This is not always recognised in current policies. The general view is still that government support should be given only in the initial stages until a novelty is 'proven', often only in a technical sense, and that thereafter it should be able to stand on its own feet. This, however, is not the way system innovation processes work. Longer-term policy support is required, although the type of support may change over time. As there is little experience in how to actually do this, it requires further investigation, often in a process of 'learning by doing'.

Standards can play an important role in defining markets for sustainable innovations. But they are usually enacted on the basis of 'proven' novelties rather than on what may be needed from a sustainability perspective. There is

consequently a risk that standards become a barrier to further innovation, which makes it important for them to be flexible and 'progressive', so that there is a premium on further innovation beyond the level of the standard. This is possible because, contrary to widely held views, standards do not standardise practices but organise them. The trick then becomes to implement standards that reward further innovation.

Developments towards sustainable agriculture should be guided by some sort of vision of a direction in which to move. But different stakeholders tend to have very different opinions on what constitutes desirable directions for development. This raises the question of whether it is possible to build some sort of shared vision between stakeholders, one that would allow a form of tuning of efforts. While shared understanding is required to envision a common future, the development and empowerment of processes of change is a pragmatic and dialogic problem for those who seek to stimulate system innovation. It calls for methodological thinking in action, at the heart of transition processes. Such reflection should be a basic requirement for both researchers and facilitators. Many of the discussions at our workshop highlighted this necessity to elaborate scientific views and methodological requirement concerning the sense and practicality of action for researchers. The notion of co-design was thus considered as a property of the design of socio-technical devices for transitions to sustainable development.

3. CO-DESIGN IN TRANSITIONS

The RIO methodology provides one way of form of co-design. Applied to the domain of animal production, this method led to radically new designs for husbandry systems. One of its key features is that new designs are an intermediate step between broad future visions and concrete novelties. They make the visions tangible, so to speak. The method also supports one of the conclusions drawn above, that it is important to engage a variety of stakeholders in transition processes, which is also corroborated by another paper on design processes. Since these approaches involve multi-stakeholder dialogue, the result is that whatever radically new design the process renders, it has broad support, which enhances the chances of implementing it successfully in practice.

At the workshop, two co-design approaches were presented and discussed. Although they have been applied for rather different purposes, they share a fundamental starting point in seeing design as a dialogical process. A recommendation for policy is that it is important that both approaches be applied in a variety of situations to gain more experience on their strengths and weaknesses in different situations.

To overcome the problems of modern agriculture, the development of new knowledge is required. It is commonly believed that researchers develop this new knowledge, which is subsequently implemented in practice. Various papers have

shown, however, that a transition also has to be based on local, tacit knowledge and to engage innovative farmers who are working on new solutions.

But although important, such local knowledge can provide only part of the answer. This is evident when looking at the various dimensions of sustainability. Local stakeholders will bring in the local issues but some sustainability issues go (far) beyond local borders. How to bring this into the process is an open question. There are, as yet, no proven methodologies on how to find the right balance between 'the local' and 'the global'.

The purpose of stimulating niche developments is that, eventually, they influence regime developments and start a transformation towards sustainable agriculture. There is a risk, however, if this happens too soon, i.e. if the innovations become widely used before they have been adequately explored and tested. This was illustrated in a paper on the use of meat and bone meal as animal feed. While it seemed attractive as a way of recycling waste, it later came to be seen as highly problematical in connection with BSE. The problem, of course, is that such errors easily appear with hindsight but are difficult to anticipate as part of the 'full picture' of an innovation and its potential consequences. No fool-proof methods exist to carry out such assessments, but this case points to at least one possible improvement. The fact of relying on too narrow a circle of actors is likely to result in a myopic view that is blind to a possibly broader spectrum of issues. It is therefore important to engage a wider range of actors who look at sustainability from a variety of different angles.

4. FINAL CUT

In the general discussion covering a range of papers, several participants felt that the agricultural sectors were more open for innovation than, say, a decade ago. This probably is largely due to, in the MLP terminology, the landscape pressure for sustainability that has increased significantly and is likely to continue to do so in the foreseeable future. But at the same time, changes towards sustainability are still modest. Openness to innovation largely comes from a rather small group of pioneers that are willing to explore new ways while the vast majority still resists change. This reflects that system innovation is a long-term process and the growth of the number of pioneers is an important step in the initial phases of this process. The pioneers represent an important channel through which niches link up to a regime. This may mark the beginning of a process, which may eventually result in the transformation of a regime.

Policy makers, however, press for urgency and stress that change is required in the near term. This puts pressure on niche actors to create early links with regime actors – with a risk of losing the radicalness of the innovation. Policy makers should be aware that this may jeopardise the longer-term potential of such innovations to lead to more fundamental changes with larger sustainability benefits. It is important to create clarity in such situations, on the objectives of a project. It should be clear whether it is intended to lead to near-term

improvements on a specific issue or to contribute to a longer-term process of fundamental change leading to an integrally sustainable agriculture.

Regime change (or system innovation) cannot be predicted and pinpointed exactly. This implies that it is not possible either to develop fail-proof policies to stimulate regime change. The best one can do is to influence a variety of factors that might be advantageous for a regime change. Historical analysis may give some clues on how to achieve this, but only indirectly so because past transitions were rarely the result of deliberately governed transition processes. Therefore, we cannot draw on work that shows how it must be done. If one wants to govern or work on processes towards system innovation, one has to do it from the perspective of the here and now, and try to look for ways towards this promising future. We have to acknowledge that we are in a messy situation of trying to find out what could be effective ways to contribute to a transition towards sustainability.

What complicates the situation is that there are various concepts of sustainability. We are dealing with different people who work on this challenge from different angles. Transition analysis can give us some clues on what might be done but from there on we are exploring unknown territory and have to engage in a process of learning by doing.

System Innovations, Knowledge Regimes, and Design Practices towards Transitions for Sustainable Agriculture

Over the past decade, the transition towards sustainable agriculture has been a central theme in the work of many organisations, including government bodies, NGOs, professional organisations and research institutions. Various publications, including White Papers by the EU and different national governments, define future targets and objectives to improve sustainability in various sub-sectors like animal production, arable farming, or glasshouse horticulture. There are furthermore growing concerns about the sustainable use of biomass for fuel, feed and fibres, which also became public issues in terms of ethical or economic relations regarding the multi-functionality of agriculture.

It has become clear that the development of our industrial societies has had serious negative effects. This is true for a variety of sectors including the agro-food system (*sensu largo*, that is, including the production of food, feed, fuel and fibres). Despite most governments' adoption of the notion of sustainable development as a basic policy principle, it is becoming increasingly clear that the achievement of a 'post-industrial' society will not necessarily result in a more sustainable society, i.e. a society that is characterised by a better balance between economic, social and ecological goals. Ensuring that any transition that might be taking place does lead to more sustainability is a major challenge for societies in general and for agro-food systems in particular. In this context the relations between agronomic science, agricultural technologies, and public or private expectations are at stake. This leads to claims for "innovative innovation" concerning the purposes and ways of designing new technologies and practices, or new practices in relation to existing techniques. In fact, these claims indicate a need for a shift in the governance of research and innovation to achieve a sustainable future.

This book is directed at those involved in research activities and decision-making that target sustainable transitions of the agricultural sector, food system and more largely environmental planning and ecosystem services. The contributions provide substantial reflections and case studies, and question the type of relationships and knowledge exchanges that should enhance the delivery of more sustainable system innovation and foster more diversity in the governance of transitions.

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