Regime Change and Storylines

A sociological analysis of manure practices in contemporary Dutch dairy farming

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‘And life ain’t nothin’ but a funny, funny riddle
Thank God I’m a country boy.’

John Martin Sommers, as recorded by John Denver.

Ik draag dit boek op aan mijn vader Aalt Stuiver

Contents

1 Introduction

1.1 Introduction

This thesis starts with the presentation of a non-contested societal fact: since the 1980s, Dutch dairy farming is in crisis due to the excessive production of polluting amounts of manure. Manure has become a metaphor for everything that went wrong with agriculture; smell, algae in surface water, nitrate in groundwater and tractors on the highway (KLV, 1996). As a consequence, different groups of actors have gathered and set up new and various types of experiments to discover ways to overcome this problem. Examples of these practices can be found in the setting-up of new research projects (e.g. Ekkes and Horeman, 2004; Grip, 2002; Anonymous, 2002), farmers that develop and rediscover long-forgotten practices (e.g. Goewie, 2002; Wolleswinkel *et al*.., 2004), government policy adaptations and new advisory schemes (e.g. Anonymous, 1995a; Ministerie van Landbouw, Natuurbeheer en Visserij, 1994; Commissie Bemesting Grasland en Voedergewassen 1998). As a consequence, the modern manure regime with its dominant rules, routines and knowledge practices has been in a period of transition for the last two decades.

The changes that are required to make the manure regime more sustainable also involve the knowledge infrastructure associated with the old regime (Nijkamp, 2003; Anonymous, 2000a; Van der Meulen, 1996). In the agricultural sector, the knowledge infrastructure that sustains the dominant regime played, and still plays, an important role. The relations between the sector and the dominant knowledge infrastructure can be characterized as linear, top down and supply driven (Smits, 2006:1). Innovations were based on the production of new knowledge within research institutes and laboratories. The claim was that, through extension and education, the route of innovation ended in the successful application of this knowledge by farmers (Schot *et al*., 2000; Baars, 2002; Smits, 2006).

Now that the manure regime is under pressure, the question which knowledge is relevant is also being discussed. The focus of the discussion ranges from observations and data to (epistemological) storylines about what is ‘good’ manure. This is why it is important to study new manure practices, if one wants to understand the transition in the modern manure regime. The object of the research for this thesis therefore includes the practices in which different actors experiment with finding alternatives to the manure regime, and the way in which these practices are embedded in wider structures and developments, i.e. how the experiments have resulted in a niche where an alternative way to look and deal with manure, compared to the old regime, can be pursued.

These practices have been studied before (although not in as much detail as I will offer), either from an agricultural-science perspective (e.g. Sonneveld, 2004; Reijs *et al*., 2004), or from a change perspective (e.g. Milone, 2004; Wiskerke and Van der Ploeg; 2004) how to nurture novelties if they go against the dominant regime. I will add a sociological perspective, namely one in which the central role of epistemological dimensions of niche formation and regime change is recognized. That is why I will use the concept of storylines. During experimentation and niche formation, the actors involved not only develop and test new socio-technological configurations, but they also try to find a common storyline that gives the new configurations meaning beyond the experiment and within the niche.

The larger picture is that my topic and approach are situated at the cross-section of two societal developments, the changing role of agriculture, and changing views on and practices of, knowledge production. I will briefly discuss both before I tell (in section 1.2.) the story of how my research topic and research questions became delineated.

Agriculture occupies an important place in Dutch economy; ten percent of the economic activities in the Netherlands are related to agriculture and more than half of the Dutch surface is occupied with farming activities (Van der Stelt, 2007: 10). Dairy farming is one of the major sectors in Dutch agriculture. At the same time, the number of dairy farms has decreased rapidly over the past years. Beldman *et al.* (2006: 18) state that from 1995 until 2004, 35% of the farms have disappeared up until the number of 24.332 farms in 2004. The average milk production at that time was 450.000 kg of milk. Thousand farmers produce more than a million kilogram of milk during a year (Beldman *et al.*, 2006: 19). Dutch dairy farming is based on highly efficient and intensive production of agricultural goods. Large quantities of input like fertilizer and concentrates are imported to the farms. In contrast to this, relatively small amounts of the imported nutrients leave the farm in consumer goods (milk, meat or feed) and so the remaining nutrients are excreted by the animals in the form of manure (Van der Stelt 2007: 10).

Over the last few decades, Dutch dairy farming has been in crisis due to high levels of pollution caused by the excessive amounts of manure excreted. Large amounts of nitrogen (N), phosphate (P) and potassium (K) have created environmental burdens in different forms. Excessive nitrogen use leads to the accumulation of nitrates in the groundwater, eutrophication of surface water and is a threat for drinking water catchments' areas. Nitrogen in the form of ammonia also causes 'acid' rain, which is damaging to forests and ecosystems. Ammonia volatilizes during several stages in the production process, for instance during the storage and application of manure. In the Netherlands, ammonia is the main element of acidifying deposition: since 1980 it has contributed to 45%-50% of all acid depositions. In the last decades millions were spent to combat the effects of acidification and eutrophication (see Anonymous 1995).

In the past few decades, a societal demand for agricultural products that produce fewer risks for human health and natural pollutions has been articulated (Beck, 1992; WRR, 1994). New demands are articulated; sustainability is one of these demands. Sustainable agriculture aims for agri-businesses being more environmental-friendly, economically viable and also concerned with the social organization of agriculture (the latter fits the presently fashionable storyline of People, Planet, Profit). It is reflected in European and national legislation (Van Bavel *et al.*, 2004; LNV 1995; Henkens and Van Keulen, 2001).

The move towards sustainable agriculture needs to be supported by knowledge and understanding of sustainability. Many practitioners and commentators have argued that traditional ways of knowledge production are not sufficient to meet this challenge. In fact, there are non-traditional ways of knowledge production going on already, outside the universities and research institutes. There is a general trend to move from knowledge production in a traditional research context to knowledge production that is socially spread; application-oriented, trans-disciplinary and accountable to multiple audiences (see Nowotny *et al*., 2001). The new roles of patients' associations, in setting research agendas and actually contributing to research, are a clear example (Callon 1999: 90).

In agriculture and nature conservation, there is now more appreciation of local knowledge (Ellis and Waterton, 2005). Concurrently, innovation in agriculture is seen as a non-linear process, in which many actors are involved. New ideas can originate from practical experience, and the role of science in the innovation process is often limited (Leeuwis *et al*, 2006). For example, entrepreneurs meet each other in various practices and niches for sustainable development (Landbouw-Economisch Instituut, 2000; SER 2002). The Dutch government initiated a number of programmes to enhance the rise of a new knowledge infrastructure in the Netherlands. One example is TransForum in which entrepreneurs, non-governmental organizations, government officials and scientists meet to exchange knowledge and develop innovations for a sustainable agriculture (TransForum 2006: 2). Another example is the Taskforce Multifunctional Agriculture that was initiated by the Dutch government after several organizations signed a manifesto in which they argued for more government support and coordination in knowledge exchange between stakeholders to increase a multifunctional agriculture in the Netherlands (Anonymous, 2006).

1.2. Research topic and research questions

The formulation of the research problem is the result of a process of observation and induction that I undertook during my fieldwork and my continuous and contingent search for new practices and places where actors experimented with sustainability.

My research started with the task given by scientist Van der Ploeg to map the significance of farmers' knowledge for the development of sustainable practices in the Nutrient Management Project of the environmental cooperatives *Vereniging Eastermars Lansdouwe* (VEL) and *Vereniging Agrarisch Natuur en Landschapsbeheer Achtkarspelen* (VANLA)[i]. The first time I entered this field of enquiry was during an excursion on soil management, organized by a group of farmers from this Nutrient Management Project. Together with scientists Verhoeven and Eshuis, I put on my mud boots and we entered the meadow of farmer Bloemhof, our host. 'Do you want to help digging?' was the first question he asked when I arrived.

'With the Nutrient Management Project we aim to make manure that is good for our soils and groundwater', was the synthesis made by project leader Dijkstra during the excursion, 'and today we look at our own methods how to do this.' Digging a hole and looking with the farmers at the number of worms in the topsoil seemed to open a world under the surface that contained experimental options for the future.

During the first months of my research, I encountered several places where people were experimenting with manure: at dairy farms, at the agricultural departments and within experimental stations. In some way or other, the people I met were also connected to each other. They referred to each other either as colleagues or contestants in the search for new and sustainable manure practices. In their stories they told me about their conceptions about manure. I heard words as 'truth' and 'false', 'novelties' and 'old routines', when I spoke to them, and these various truths were not the same for each one of them. For instance, during my conversations with scientist Schröder from Plant Research International (PRI), he told me that the body of knowledge on manure and grassland management was adequate to solve the problems in agriculture as long as the farmers would follow the guidelines resulting from it. However, one of the farmers in VEL and VANLA, farmer Oosterhof, told me that he did not believe the guidelines expressed, for instance, in the Manure Application Advice (Commissie Bemesting Grasland en Voedergewassen, 1998). He wanted to apply manure in his own way, and he started to mistrust the advice of scientists. A further example is my encounter with scientist Van Bruchem, senior researcher at Wageningen University, who criticized the scientific practices of the Department of Animal Sciences, whereas in my conversations with other scientists, they told me that Van Bruchem's claims were based on hunches and not on 'sound science'.

I was not in a position to adjudicate among these various truth claims, even when the question who is 'right' cropped up immediately. After a while I realized that precisely this question would not take me any further. I became interested in how these different truths are constructed, and started to read the work of Latour, Callon, Law and Rip, proponents of the constructivist approach within sociology of scientific knowledge (Callon, 1986; Latour, 1987; Law, 1994; Rip, 2000a). As a sociologist, I could make a contribution to the empirical understanding of the social and cognitive construction of knowledge, exactly by studying the practices and interactions of different experts in manure.

This became the conceptual backdrop to the task Van der Ploeg had given me, to study farmers' knowledge: it was part of his claim that innovations were made out there on the ground and that sociology could prove that these innovations were important. He is a leading author within rural sociology to argue that farmers develop alternatives to modernization, and he stresses the innovative potential within local farmers' practices (Van der Ploeg, 1993b; Van der Ploeg, 1999; Van der Ploeg and Long, 1994). In his opinion, scientists and politicians need to make use of this knowledge and expertise, even if these are based on different epistemologies than the ones dominant within the scientific domain (see also Callon, 1999; Wynne, 1996). He is not the only one who recognizes the existence and potential of laymen's knowledge for rural development (Long, 1992; Marsden *et al*., 1996; Marsden, 2003; Long, 2001).

Aligning myself with the constructivist approach within sociology of scientific knowledge, I had to face the issue of relativism: there is no universal truth, and so every truth claim is as good as any other claim. This is patently nonsensical, and so it could be used as an argument to discount all constructivist approaches. Some authors in the constructivist approach have formulated their claims in such a way that they become vulnerable to this argument. Others have distanced themselves from relativism by referring to engineers who construct bridges (Rip 1994): there is no guarantee that the bridge will be robust, and indeed, bridges have been known to collapse. That does not alter the robustness of most bridges, and our trust in them when we cross a bridge.

The constructivist tradition does not actually deny the reality of scientific truths but it has another object of research, namely the process in which knowledge claims become true (Sarbin and Kitsuse 1994; Potter, 1996). Social constructivism considers facts or truths as the outcome of interactions, conflicts and alignment. This implies the existence of heterogeneous forms of knowledge: since actors produce knowledge in different contexts, their knowledge will differ both in terms of content and orientation. The constructivist approach also treats the distinctions that are often made between experts and laymen, politicians and scientists, nature and culture and micro and micro, as outcomes of these social interactions. To me this was useful since I was given the task of understanding how the divides between 'truth or false', 'novelties and old routines' 'scientific and farmers' knowledge' are reconstituted or challenged within the discursive practices I became participant in.

This thesis provides a sociological analysis of manure practices. In this way it wants to contribute to a better understanding of transformations in the modern manure regime in Dutch dairy farming. The object of research is a selection of practices in which different actors experiment with finding alternatives to the modern manure regime. The case studies focus on these practices because the question 'what is valid knowledge' is contested and articulated. In this way it aims to unravel the ways knowledge is produced, discovered, black-boxed and used in possible innovative ways to overcome the sustainability problems of the present manure regime.

The case of manure is selected to study the social and cognitive construction of knowledge. At the start of my research, several nutrient management projects took place that included experimentations with manure practices and knowledge development (see Aarts, 1988; Aarts, 2003; Benedictus *et al*., 2001). In the debates among the experts in manure, the need to change the manure regime towards sustainability was acknowledged, but the correct ways and knowledge to do so were often contested (e.g. Noorduyn, 2003b; Roep *et al*., 2003). I had a good entry and became involved in the debates and the projects that took place.

One example of farmers that made experiments with manure practices was the Nutrient Management Project of VEL and VANLA. From 1994 onwards, the dairy farmers belonging to the VEL and VANLA cooperatives developed their own novelties to reduce and overcome pollution. They wanted these novelties to fit into their farming systems adapted to the landscape of small-scale parcels with hedges and belts of elder trees in the Frisian Woodlands. From the beginning, the farmers cooperated with agricultural scientists to realize these goals, which led to the founding of the VEL and VANLA Nutrient Management Project in 1998 (see Atsma *et al*., 2000:5). Furthermore a new platform of farmers emerged, called *Platform Minderhoudhoeve Ossekampen VEL* en *VANLA* (PMOV) that considered itself as innovative and wanted to increase the exchange of expertise and innovations between farmers (Schiere and Janssens, 2007). Several other nutrient management projects that focused on the knowledge of farmers and scientists for sustainable manure practices started as well. Examples are the projects *Koeien* en *Kansen, Praktijkcijfers* and *Bioveem*, which aims were to develop knowledge on manure within the context of the dairy farms (Aarts, 1988; Grip, 2002; Anonymous, 2002; Baars, 2002). Scientists mapped differential farm practices about manure (Eshuis *et al*., 2001). Other farmers decided to start environmental cooperatives or study groups to experiment with the integration of these new demands of sustainability in their manure practices (Renting, 1995).

To study the processes of innovation from birth, I will follow the institutional approach to innovation (Weber *et al*., 1999; Roep *et al*., 2003), which is particularly suited to my research questions, because it can accommodate epistemological issues linked to institutional issues. The institutional approach distinguishes three levels of innovation: the level of niches; the level of regimes and the level of landscape. The concept of Strategic Niche Management (SNM) is used not only to describe what is happening at the VEL and VANLA Nutrient Management Project and other experiments, but also to assess the potential for a regime shift. This is possible because SNM is a theoretically informed approach to change: it aims to create technological niches and to work towards a regime change (Geels, 2002; Weber *et al*., 1999; Kemp *et al*., 2001; Geels and Kemp, 2000).

In order to study the knowledge production between scientists and farmers in experiments and niches, the institutional approach is enriched with the concept of storylines. During experimentation and niche formation the actors involved not only develop and test new socio-technological configurations, but they also try to find a common storyline that puts a meaning on the new configurations. Storylines are narrative patterns commonly developed and narrated by members within a certain community of practice (see Wenger, 1999) to attach significance to their social and physical activities. The storylines can be made visible through written or oral representations of a sequence of activities that are combined in a plot (Bruner, 1986). In this way the plot, or commonly agreed storyline, governs and attaches significance to the succession of the events. The storyline thus provides members with a common frame of meaning that makes their social and physical activities legitimate and relevant.

The objective of this research was to perform an in-depth study of a selection of knowledge practices on manure within Dutch dairy farming and their effects on the dominant manure regime.

The following research questions are important in order to achieve this objective:

1. What is the modern manure regime in Dutch dairy farming and how has it developed in the course of time?
2. What knowledge practices and innovations developed in response to the crisis in modern manure regime?
3. What storylines on manure appeared within the Nutrient Management Project of VEL and VANLA and how have these developed in the course of time?
4. What is their possible contribution to niche formation and regime change in Dutch dairy farming?

1.3. Case study selection and empirical approach

The selection of case studies has developed in the course of time, as I entered different knowledge practices in Dutch dairy farming. The first set of practices that I studied was developed among the members of the environmental cooperatives of VEL and VANLA. My first introduction to the VEL and VANLA cooperatives was when I participated in the international multi-disciplinary research programme titled 'Towards new technical-institutional design methods: the integrated down-scaling of agricultural processes of production to new levels of sustainability', often referred to as Agrinovim (Wiskerke and Van der Ploeg, 2004). This programme was financed by the Dutch Council for Scientific Research (NWO) and was a collaboration between Twente University and Wageningen University (The Netherlands), the University of Perugia (Italy) and the University of Natal (South Africa). Apart from the Abruzzo mountains in Italy (Milone, 2004) and KwaZulu Natal in South Africa (Adey *et al*., 2004), the Frisian Woodlands were chosen as a research area to perform the research activities.

The Frisian Woodlands, or more specifically, the environmental cooperatives of VEL and VANLA have been documented extensively as locations where new manure practices were experimented with (see Reijs *et al*., 2003; Roep *et al*., 2003; Wiskerke and Van der Ploeg, 2004; Eshuis, *et al*., 2001). An environmental cooperative is a regional organization of farmers who collaborate in order to integrate environmental values into their production process (Glasbergen, 2000).

In 1994, the Dutch government agreed that dairy farmers belonging to the VEL and VANLA environmental cooperatives would be allowed considerable freedom to develop their own novelties for reducing the nitrogen losses at their dairy farms. In return, the farmers promised to achieve the environmental targets set by the government faster than other farmers. In the Netherlands, farmers looked for cooperation with agricultural scientists to realize these goals, which led to the creation of the VEL and VANLA Nutrient Management Project (see Atsma *et al*., 2000).

The goal of the Nutrient Management Project was to find cost-effective solutions for environmental problems, which would meet the government's environmental targets and which would be appropriate to the local context (i.e. the local farming systems and the agro-ecological and social environments). The project focused on nutrient management and in particular on decreasing the use of fertilizer, improving the quality of manure, adapting the application of manure and improving the soil quality. The project involved a wide variety of farmers, with various styles of farming, education levels, milk production levels and environmental achievements. Various scientists participated in the project, including agronomists from the Research Institute for Animal Husbandry and Plant Research International, as well as soil scientists from Wageningen University.

To characterize the Nutrient Management Project briefly: basically, the farmers were in charge of the project. This was laid down formally in the organizational structure, which was headed by the environmental cooperatives. Two project leaders were in charge of day-to-day project management: Verhoeven from Wageningen University and Dijkstra, a staff member of the Dutch farmers' organization LTO. At the beginning of the project, a research council was established to help design and govern the Nutrient Management Project. During the meetings of the research council, a large and varied team came together. The chairperson of the research council was Brussaard, professor of Soil Biology in Wageningen, who was very committed to increase the expertise in farming systems and organic soil processes (Wiskerke *et al*., 2003; Goede *et al*., 2003). Animal scientist Van Bruchem and Professor of Rural Sociology Van der Ploeg from Wageningen University and Research Centre were the initiators and leaders of the project from the very beginning. Agronomists Vellinga, Schils and Schröder from The Research Institute for Animal Husbandry and Plant Research International (PRI) were present during the meetings of the research council. Their participation was partly formulated as a prerequisite for the subsidies from the Dutch Government and they also provided knowledge on manure practices and agronomy. Another important participant was Bouma, professor of Soil Science. He was involved in research in the field of soils and landscapes (Sonneveld and Bouma, 2003). Furthermore, he was a member of the *Wetenschappelijke Raad voor het Regeringsbeleid* (the Dutch scientific council for government policy, herafter referred to as WRR). In this role, he was committed to develop expertise in the new significance of local initiatives in new governance experiments (WRR, 2003).

Several researchers, including Wiskerke, Reijs and Sonneveld, members of the international research team of Agrinovim, provided their expertise in theories of transition and experiments (Wiskerke and Van der Ploeg, 2004). Farmer Benedictus and farmer Atsma were chairpersons of the cooperatives from the beginning, and they had numerous and various contacts with government authorities and with agribusiness and farmers' organizations. They had experience in improving social cohesion within the environmental cooperatives and in mobilizing farmers to participate in the Nutrient Management Project.

I participated in the Nutrient Management Project VEL and VANLA from 1999 until 2004. This participation included elements of action research (cf. Argyris *et al.*, 1985; Reason, 1998; Gold, 1997). I became involved in the development of knowledge that was directly relevant to solving the problems the actors were faced with. I cooperated in making progress reports of the Nutrient Management Project (e.g. Atsma *et al*., 2000) and I facilitated workshops at the research council meetings. Together with

Eshuis, Verhoeven and Van der Ploeg, I published a book about manure practices among the farmers (Eshuis *et al*., 2001). Through my active participation in the day-to-day activities of the Nutrient Management Project, the farmers got to know me well and trusted my expertise in the subject matter, which helped me to gain a more in-depth insight during my conversations with them.

The data collection methods I used included interviews and participant observation. Participant observation actual captured my dual role in the research process. In order to develop an understanding of the research practices, I became a participant, while still maintaining the position of an observer, someone who describes the experience. The participatory observation took place with the sixty farmers and fifteen scientists involved in the project. In addition, the Nutrient Management Project organized two platforms in which farmers and scientists got together and exchanged information and learned about their activities; the research council and the study meetings. During these meetings, I made use of interviews and participatory observation. I observed the actors and their contributions to the meetings and I held informal conversations (unstructured interviews) to uncover their contributions to the project and their own roles within the project.

My involvement in the project on behalf of the Agrinovim team resulted into input into the process, since I presented insights into topics like learning processes, knowledge production and Strategic Niche Management. At the same time, in order to understand the different storylines on good manure, I had to talk with several sources. I visited farmers to learn and understand their languages: Frisian words, knowledge, indicators and value judgments. I also participated in discussions and observations among scientists to understand the terms they use for soil and landscape, manure and animal feeding.

The second set of practices I studied was based on my interviews with eight farmers. I needed a variety of farmers who started to make good manure. Eight farmers were considered to be sufficient to guarantee the diversity needed. To select the interviewees, I used the Nutrient Management Project VEL and VANLA and PMOV. Van der Ploeg, Van Bruchem and Verhoeven assisted in the process of selecting the farmers. With each farmer, I explored his personal view on the development of his manure practices. During the first interview, I asked the farmers to tell what actions they were taking to make good manure. It turned out there was a common understanding about the storyline of good manure, as this was part of the nutrient management projects they were all engaged in. During the second interview, the farmers evaluated their strategies and actions and discussed the adaptations they had made. Reijs, a researcher in animal sciences who joined me during the meetings, was able to clarify the aspects of animal nutrition more clearly as he confronted his expertise with the expertise of the farmers during the conversations.

I also collected the relevant data and indicators to understand the material evolvement of good manure practices at their farms. I collected data from a variety of sources to see how the indicators at the farms developed. The findings were analyzed against the background of a series of ten other interviews about manure. I held (together with scientist Groot) eight in-depth interviews for the 'Project on the Manure Application Advice' (see chapter 7) and I stayed at two farms, not only to learn about the practical implications of making manure, but also to learn how to milk the cows and ride a tractor.

The third set of practices I studied dealt with the attempts made by farmers and scientists to change the existing regime. I performed an in-depth literature study. I read governments documents and scientific reports that dealt with the issue between 1990 and 2006. I followed the debate in scientific papers, project journals and policy documents and I read the newspapers that dealt with the issues. I interviewed stakeholders to get an overview of the various arguments and standpoints. I interviewed members of the Nutrient Management Project about their attempts to change the regime. I also focused on the rise and emergence of storylines in other nutrient management projects in the Netherlands like *Koeien* en *Kansen, Bioveem*, *PMOV* and *Praktijkcijfers*. I have studied these nutrient management projects by means of literature study and by talking to informants like the project leaders (see chapter 7) and farmers involved in the projects (see chapter 5).

In the fourth set of practices I studied, I could use my participation in two research projects as a basis; the 'Wageningen Working Group on Experiential Knowledge' and the 'Project on the Manure Application Advice'. I enrolled in both projects because of my work as a social scientist for the Nutrient Management Project in VEL and VANLA. In both projects, I conducted research and I was also project manager. At the same time I used the cases to study and learn about knowledge production in the Agricultural Sciences. I treat the case studies as de facto strategic lessons. Although the actors designed the processes to a certain extent as well, they did not rephrase them in the terms I used.

The different sets of practices that I studied showed storylines and their travels and allowed me to trace them. The first method to trace these storylines was to follow the narrators and the ways in which they articulated the storylines in the practices I studied. I looked at their experiments and attempts at niche formation. This was done through interviews, participant observation and situational analysis (Van House, 1999). The second method was to examine the artefacts that were successful allies in making the storylines robust within the carrying network. Examples are texts (like articles, papers and presentations), images, technologies and databases (Higgins, 2006: 52).

1.4. Overview of the chapters

Chapter 2 provides a methodological framework. I propose to look at transition from a multi-level approach, in contrast to more linear approaches. I present a conceptual framework derived from Strategic Niche Management. I will describe what the different levels entail: practices, experiments and niches. I will explain how knowledge development is taking place at these levels. I will also present a definition of storylines and explain why this is a worthwhile contribution to understand the role of knowledge production and regime change. I describe the way storylines can be recognized in multi-actor experiments and how they can be traced in their travels through the strategic niches they become part of.

Chapter 3 describes the development of the food and manure regime in the Netherlands. For a major part, the environmental problems in dairy farming are caused by the rapid growth of the amount of animal manure. All these tons of manure find their origin in a dominant way of acting and thinking about animal manure; the manure regime within Dutch dairy farming. This chapter deals with the influence of different types of practices that sustain the manure regime. Both farmers' practices as well as political-scientific practices have played a role. The chapter describes three stages in the rise and growth of the manure regime within Dutch dairy farming. The first stage concentrates on the process of knowledge development within the agricultural sciences and associated innovations on minerals that became the basis of the manure regime. The second stage is the stabilization of the manure regime, with a knowledge infrastructure strongly based on the overall modernization paradigm (see Schot *et al*., 2000, Van der Ploeg, 1999) and the linear model of innovation (Groen *et al*., 2006: 55). The third stage is a period of reconsideration of the manure regime and the related knowledge infrastructure. The regime was criticized for the production of 'bad manure': namely manure that is polluting air and groundwater. Furthermore, different actors started to pose questions about the knowledge infrastructure and the innovation models involved that were the basis of the manure regime. Finally, the Dutch government initiated a number of nutrient management projects and introduced new policies to regulate the application and reduce the volume of manure.

Chapter 4 takes a look at the joint effort of scientists and farmers within the Nutrient Management Project of VEL and VANLA to experiment with novel manure practices. Different forms of knowledge production are experimented with, and scientists and farmers negotiate about which knowledge serves the purpose. A set of storylines emerges, developed and narrated by the participating farmers and scientists to attach significance to their social and physical activities. The first storyline embraces the notion of good manure. The second storyline is about system thinking as an alternative to other methods of scientific thinking. The last storyline is the David vs. Goliath plot: David incorporates resistance to the Goliath of the existing regime, and suggests that the niche the farmers and scientists attempt to create will be successful to overcome Goliath. Through this storyline the farmers get a central role.

Chapter 5 portrays eight farmers that make good manure, and it describes their actions in order to make good manure and what they are faced with when they try to make good manure. The different actions are categorized under the two strategies that I derived from Eshuis *et al.* (2001: 21); improving the quality of manure and improving the utilization of manure. It gives a first analysis of their strategies. What became clear during the investigation is that, although the farmers share the storyline of making good manure, they make local variations on a farm level. The chapter looks at the ways the farmers use indicators in focusing on making good manure. The chapter interprets indicators as monitoring units for pursuing their strategies. The chapter continues with an analysis of the constraints the farmers experience in developing their strategies. It interprets these constraints in terms of the increased tension between their farms as protective space in which good manure is developed, whereas at the same time the farmers have to operate in the existing manure regime.

Chapter 6 explores the attempts made by agents that tell the storyline of good manure in order to create changes at regime level and the ways in which these attempts work out. The chapter is divided into two different aspects of the manure regime: policies regulating the application of manure and policies regulating the volume of manure in the Netherlands (Henkens and Van Keulen, 2001). The chapter first presents the manure regime on application policies and volume policies. Then it looks at the interactions of the storytellers of good manure with the rules and regulations on manure application technologies and with volume policies. It also gives an overview of other attempts made by the agents to create changes at regime level and their interplay with other networks that dealt with the same issues.

Chapter 7 describes two case studies in which heterogeneous groups of actors attempt to improve the knowledge production processes for sustainable agriculture. The first case is the 'Wageningen Working Group on Experiential Knowledge', a temporary network of scientists involved in nutrient management projects in the Netherlands in 2000. The second case is the 'Project on the Manure Application Advice' a temporary network of experts in management support systems for dairy farmers in their manure application strategies, which took place in 2002 (see Groot *et al*., 2004). It describes how the projects came into being and it describes the reasons why the participants wanted to establish the projects. It looks at the perceptions of the actors how agricultural knowledge production should change, in order to stimulate farmers' practices on good manure and to incorporate the systems perspective within the agricultural sciences.

In chapter 8, a number of conclusions are sketched out. Firstly, a synthesis is made of the current state of the manure regime in the Netherlands. It argues that the diverse knowledge practices that have been developed in response to the crisis have resulted in a viable niche. Secondly, the specific role of storylines and their contribution to niche formation and regime change are described. Thirdly, the new role of scientists to develop and strengthen a new knowledge infrastructure is brought forward.

2. From local practices to regime change: theories and concepts

2.1. Introduction

In this chapter[ii] a multi-level, multi-aspect and multi-actor approach is presented for a better understanding of the dynamics between local practices and regime change. Institutional approaches to regime change focus on the dynamics of rules and interactions between actors on different levels. Strategic Niche Management focuses on how local practices become protected in such a way that novelties can mature, whereas at the same time through management in different domains, it can lead to niche branching and possible regime change. The concept of communities of practice can be used to grasp the dynamics within the local practices. I will add a perspective in which the central role of epistemological dimensions of niche formation and regime change is recognized. Therefore I introduce the concept of storylines. The actors involved not only develop novelties, they also try to find a common storyline that attaches significance to the novelties beyond the local practice and within the niche. Tracing storylines in their travels through the strategic niches they become part of, is a way to study the extent of regime change.

In section 2.2., I introduce the institutional approach to look at transition. I present concepts derived from Strategic Niche Management. I describe what the different levels entail: practices, experiments and niches and I describe how knowledge development is taking place at these levels. In section 2.3., I clarify the focus on local practices. In section 2.4., I present a definition of storylines and explain why this is a useful contribution to understand knowledge production in local practices and the effects on regimes.

2.2. A multi-actor, multi-aspect and multi-level approach to understand regime change

What exactly is a regime? The concept of regimes stems from evolutionary economics. Nelson and Winter were the first to introduce the term in 1977 (Nelson and Winter, 1977). They considered regimes to be cognitive routines, shared by engineers and designers from different companies (Geels, 2002: 97; Deuten, 2003: 32). In this thesis, the definition of Rip and Kemp is adopted (Rip and Kemp, 1998): a socio-technical regime is the grammar or rule-set comprised in the coherent complex of scientific knowledge, engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, ways of defining problems, all of them embedded in institutions and infrastructures. The last part of their definition can be developed further by thinking in terms of socio-technical landscapes; for instance the material and spatial arrangements of cities, factories, but also wars, oil prices, cultural and political values and environmental problems (Geels, 2002: 99).

The notion of regime is twofold. First of all, it refers to a shared set of rules how to act and not to act (in this case to technological change). So, rule-sets can be regarded as dominant ways of acting. Technological regimes structure, for instance, the research activities of scientists and activities of engineers. This also implies that the existing regime has influence on the type of innovations that are developed (Deuten, 2003: 32). So the rule-sets are also reflected in materiality; the various technologies, artefacts and infrastructure, since the set of rules guide technological change and design. There is also a cognitive aspect: a collective knowledge reservoir that is shared among the members of the knowledge infrastructure (Deuten, 2003: 65). This knowledge reservoir can be found empirically in intermediaries like texts, practices, technologies.

Secondly, regimes are sustained through the interactions and alignment between actors in social practices. Regimes are produced and reproduced in social practices, i.e. experiments, projects, research and government bodies, that is to say, everywhere where actors mobilise and form an alignment. A regime is also a stable set of connections between actors. Its stability also depends on non-human intermediaries, like technologies, design options and communications schedules (Geels: 98, 2002; Deuten, 2003: 32).

Regimes can dominate the process of innovation in a sector for a long period of time. The modernization of Dutch agriculture after the Second World War is an example of a dominant regime that took a long time (Van der Ploeg and Roep, 2003). Modernization was equated with increase in scale and intensification of farming. Exceptions to this dominant route to success were pushed into the background (Van der Ploeg, 1999). The environmental crisis in agriculture, due to environmental problems, opened up possibilities for a regime change. Regime change is a long process and takes many decades. Some authors state that it takes 30 years before the shift in regime from one stable regime to a new stable regime is definitive (Geels, 2002: 16).

How to understand regime change? For this purpose, the institutional view on innovation (Weber *et al*., 1999; Roep *et al*., 2003) is useful. The institutional approach distinguishes three levels of innovation: the level of niches; the level of regimes and the level of the landscape. Niches consist of the various practices where (multi-facetted) innovations are tested for their applicability as well as the coupling of expectations and networks formation (Weber *et al*., 1999). A regime refers to a shared set of rules on how to act and not to act (in this case to technological change) and to the web of connections between the actors (Rip and Kemp, 1998). The macro-level of landscape is a metaphor for structural developments (Geels, 2002: 99). The concept of Strategic Niche Management (SNM) is used to assess the potential of innovations to result in a regime shift. SNM is a theoretically informed approach to change: it aims to create technological niches and to work towards a regime change (Geels, 2002; Weber *et al*., 1999; Kemp *et al*., 2001; Geels and Kemp, 2000).

The institutional approach belongs to a family of so-called multi-actor, multi-aspect and multi-level innovation perspectives (Groen *et al*., 2006). Such perspectives have been developed in response to the linear model of innovation that claims that innovation begins with knowledge development within the academia: the process consists of finding novelties within fundamental research done by scientists, the development of these novelties within Research and Development (R&D) Centres and spreading the impact via dissemination. Academics and governments have explicitly and implicitly used this model as a justification for the flow of research funds towards research institutes, R&D centres and marketing and dissemination bodies.

A first critical modification of the linear model of innovation came from Rogers and Havelock, taking a dynamic view on the diffusion of innovation. Diffusion of innovation is the process by which an innovation is communicated through certain channels in the course of time among the members of a social system. There are five categories of actors during this diffusion of innovation; the early innovators, the early adopters, the early majority, the late majority and the laggards (see Rogers, 1962). Havelock emphasized the role of networks in the diffusion process (Havelock, 1969; Havelock, 1986). The theories and empirical studies of Rogers and Havelock still continue with a basically linear model. The original innovation needs to be spread among its potential users, who are distinguished into categories related to the adoption of the original technology.

When there is some linearity, there is also a lot of non-linearity. The first point is that modifications and adaptations of the original ideas will take place during any process of innovation, shaping the innovation and therefore changing it in the process of becoming successful or not. In Constructive Technology Assessment (CTA) the social shaping of technology is taken as a starting point for studying and stimulating innovation processes (Schot and Rip, 1997). The second point refers to the matter of innovation. Would followers of the linear model of innovations define innovations as technical devices or market objects, they are actually combinations of hardware, software and orgware (Smits, 2006:2). The third point is about the question how innovations are born. Novelties begin in chaos and are based on hunches and tentative forms, and there is no idea what they will be eventually (Abernathy, 1978). The selection, improvement and diffusion of technologies will be channelled in emerging technological trajectories, perhaps leading to a technological regime (Nelson and Winter, 1977). The birth process of innovations can be traced back through empirical analysis (Nooteboom, 2004: 13).

Figure 2.1. offers an overview of the institutional approach to innovation and regime change. Geels (2002: 102) and Roep and Wiskerke (2004: 352) developed versions of this figure.

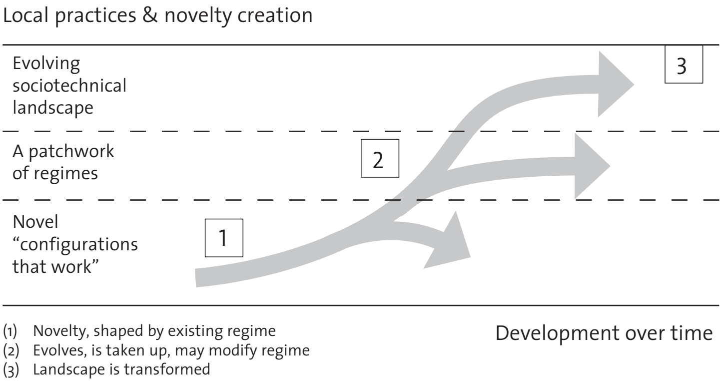


Figure 2.1. The three levels of socio-technical change (Rip, 2000b: 7)

Local practices and novelty creation are the basis of the figure. The horizontal axis is the time dimension, the vertical axis indicates scope. The institutionalization of practices is divided into three interacting stages: novel configurations that work, a patchwork of regimes and evolving socio-technical landscapes. In stage 1; the novelty is shaped by the existing regime. In stage 2; there is a transition into a regime (a new regime or a regime change). In stage 3; a transformation of the landscape is taking place.

Developing novel configurations requires a protected space (Rip, 2002: 125), a network of actors who closely work together under protected conditions and who all contribute to the generation and transfer of the novel configurations (Van der Ploeg *et al*., 2004). An experiment is an isolated and usually protected space for testing the novel configurations under specific conditions (Rip, 2002: 125). Examples of experiments can be found within all research laboratories, farms or businesses (Eshuis *et al*., 2001). During the innovation process, links are formed between what happens within the protected space and at regime level (as indicated in figure 2.1.). Although innovations are developed in a protected space, they can still be influenced by existing 'lock-ins' or irreversibility at regime level. Existing policies and legislation, but also dominating technological infrastructures shape the development of the novel configurations. At the same time, the creation of the novelties can have its effects at regime and landscape level (Roep and Wiskerke, 2004: 353; Weber *et al*., 1999: 40).

A niche represents a highly visible element of the wider set of alternative solutions and is often composed of several experiments. Adjustment has already taken place between the innovation and the wider context for its application (Weber *et al*., 1999: 19). Niches are composed of technologies, actors and their agreements to develop an innovation and protect it from the environment. In this way the applicability of the innovation can be tested and the innovation can be made more robust. Individuals, organizations and society have to rearrange themselves to adopt and adapt to innovation (Rip and Kemp, 1998). In this sense, the introduction of a new technology is an unstructured societal experiment (*ibid*).

Knowledge production processes form a key aspect of novelty production within protected spaces (Weber *et al*., 1999; Roep *et al*., 2003). Actors, i.e. farmers, scientists, engineers or retailers improve the technological experiments, reflect upon the processes and attempt to scale them up. Knowledge production in experiments is not limited to the operation of a privileged, scientific method, but it is a social product, or an effect of a network of heterogeneous groups with varying knowledge and epistemologies (Law, 1992). Fundamentally, all knowledge is contextual; it is constructed in interaction with the environment and it is embedded in the practices and epistemology of actors (see Latour, 1987). The contextuality of knowledge may be reflected on and made explicit. There is some similarity with the question as to how during the process of innovation one needs to learn about the way in which technologies and concepts work in different contexts and under various conditions (Deuten, 2003: 48).

Particularly when knowledge production and alignment within the protected space are successful, the innovations can become part of an expanding network of experiments, practices and actors. Network building and alignment play an important role in such expanding carrying networks (Weber *et al*., 1999). If the claim that the innovation works is accepted in the course of time or, in other words, is regarded as promising interesting trajectories or design options, expectations within the network will become stronger. The network will evolve and stories about the innovations will become more robust. Through different cycles of learning processes, changing networks and alignment of expectations, the process will gain more momentum and bring about a more stable and robust novel configuration (Roep and Wiskerke, 2004: 350). Apart from the growth of the network of actors, other types of activities are also important for expanding the experiment into a niche; dissemination of information, the involvement of competing parties in the network, the setting-up of partner experiments and a modification of the regulatory and political framework facilitating the establishment of new, similar experiments (Weber *et al*., 1999: 50).

Especially when the novelties experimented with represent radical changes at regime level (Moors *et al*., 2004: 38) this will bring about conflicts of interest between the parties involved (Leeuwis, 2003). For instance in the modification of the regulatory framework, the various parties can have conflicting opinions about the ways in which this framework should be altered. The various actors in the extending network can also have different opinions about the direction in which the new experiments should go, or about the degree of regime change resulting from the innovation, for instance incremental versus radical change (Moors *et al*., 2004: 38).

2.3. The significance of communities of practice for regime change

Wenger (1999) introduced the concept of communities of practice; communities of practice are formed by people who deliberately engage in a process of collective learning over an extended period of time, with the aim to gain insight and alter social order in the long run. For my purpose, those communities of practice which are gatherings of change agents in the social order are important.

Communities of practice involve a shared domain of interest between the actors, who all want to engage in learning and developing knowledge about this domain. The knowledge developed does not necessarily have to be important to others outside the communities of practice. Communities of practice also entail that the members engage in joint activities, although the degree of participation and interaction may vary widely. The members develop a shared knowledge reservoir. As Wenger argues himself; communities of practice are learning practices: social engagements between actors where learning takes place (Wenger, 1999).

During these social engagements, actors learn about different aspects of knowledge production. First of all, they learn about the development of new knowledge and the integration of this knowledge in their local practices, which is called single-loop learning. Single-loop learning refers to learning to change a way of working within a set frame of thought. Underlying principles are not questioned. The focus is on ‘techniques and making techniques more efficient’ (Usher and Bryant, 1989: 87). Apart from single-loop learning the actors also go trough cycles of double-loop learning and triple-loop learning (see Argyris and Schön, 1996). In double-loop learning, one learns to alter underlying principles, values, rules and assumptions of oneself and the communities of practice one is engaged in. Triple-loop learning looks at the processes of ‘learning how to learn’; during triple-loop learning the actors negotiate and reflect on the different epistemologies and claims to knowledge that are included in the process.

Within communities of practice, two processes are essential for creating mutual understanding: the first process is participation and the second process is reification. These two processes are in a dual relationship with each other. Participation implies that the members of the community shape their identities in relation to each other. The relationships can have different forms; they can be based on conflict and harmony and they can be intimate as well as political (Wenger, 1999). Reification means that the bits and pieces of knowledge that are learned are communicated in a reified form (i.e. tools, language or artefacts) within the community of practice and to the outside world. Reification refers to actions within the community of practice like designing, naming, encoding, interpreting and describing (Wenger, 1999).

Inevitably, knowledge production within communities of practice also involves negotiation and conflict management. While actors develop knowledge, they are influenced by existing forms of knowledge, views, ideals and interests. The actors negotiate about what can be considered as true or useful knowledge in their context (earlier described as triple-loop learning). This negotiation involves elements of conflict, struggle (Long, 1989; Long and Long, 1992) and alignment. Conflicts confront actors with the variety in opinions and interpretations. This triggers learning and change (Termeer and Koppenjan, 1997; Upreti, 2001; Voogt, 1991). Moreover, in situations of conflict, problems become more urgent and the need to address them becomes more pressing. Problematic issues have to be resolved and new insights may be gained. Conflict also urges the actors involved to formulate what they mean as precisely as possible, in order to respond to the arguments of actors with different views. By contesting the validity of each other's arguments, groups will be spurred to clarify the validity of their arguments and claims to knowledge.

2.4. The role of storylines in knowledge production for regime change

During experimentation in practices, the actors involved not only develop and test novel configurations, but they also try to find a common meaning for these new configurations inside and outside the realm of the experiment. These can be reified (in the sense of Wenger) as emerging and stabilized storylines. In this thesis, storylines are defined as narrative patterns commonly developed and narrated by members within a certain community of practice to attach significance to their social and physical activities. The narrative patterns can be made visible through written or oral representations of a sequence of activities that are combined in a plot (see Bruner, 1986). The agents and artefacts involved and their significant roles are also combined within this plot. The plot can be the plot of a particular and idiosyncratic story, but can also recur in many different stories. Then, it becomes a storyline and will govern and attach significance to the succession of the events (Polkinghorne 1995; Czarniawska-Joerges 1998).[iii] The storyline therefore provides the members with a common frame of meaning. The storyline makes their social and physical activities legitimate and relevant (see Hajer, 1995 for the case of Acid Rain in the Netherlands).[iv]

A storyline must contain a coherent message in order to be meaningful for the receiver and the giver. In other words, the storyline should relate to the experiences of both the giver and the receiver to make sense within the interaction between the actors. The different stories of the actors around a certain issue (like agriculture, rural development or modernization) can be viewed as indicators of the story skeletons about that topic and related issues that the actors have constructed and memorized. All these stories together are part of the storyline on the topic (Mildorf, 2002).

The emergence of common storylines reduces the complexity in practices. Reduction of complexity is an actor strategy. The outcome of this reduction depends on the interactions between the different strategies among the actors (Deuten and Rip, 2000: 75). One important question is how ambiguous the statements are, when a story told among actors changes into a shared belief or account of what the world is like and how sequences of action unfold. In the development towards storylines, the statements are becoming more and more educational, in the sense that they postulate truth claims that are recognized as facts by others.

When storylines sound right and suggest a common understanding (they do not go into possibly conflicting details), they create opportunities for alignment, forming coalitions and avoiding conflicts in experimentation in niches. Hajer states: 'storylines fulfil an essential role in the clustering of knowledge, the positioning of actors, and ultimately, in the creation of coalitions amongst the actors of a given domain' (Hajer, 1995: 63). Thus, they are instrumental in developing a shared discourse and building a community of discourse among the actors that together develop the innovations.

Storylines are reified in a variety of ways. One interesting way, which will turn out to play an important role in the practices I study, is through reliance on indicators. These indicators provide simplified representations of complex phenomena. They show something specific and indicate something more comprehensive or general. Thus, indicators influence observation and experience. Indicators focus observation; the experience of something comprehensive is reduced to something specific. Indicators enable and sharpen observation but also narrow it. Indicators may cause blindness to other phenomena that are not indicated, thus literally becoming blinding insights. A farmer, who is focused solely on the quantity of milk, may – unwittingly - neglect the quality of the milk or the health of his cows. During experimentation, indicators facilitate measuring (quantifying), registering and monitoring. In social learning processes, indicators have an additional function: they provide a shared perspective. By using the same indicators, people focus on a common dimension, which facilitates comparison. The indicators that farmers use come from a variety of sources. They can be developed in science and advisory schemes, but can also be developed on the basis of experiential knowledge (Van der Ploeg, 1993b). During the modern manure regime, the development of indicators was based on the storyline of aiming at high production levels. This implied that the indicators the farmers used were in line with this aim. During experimentation with innovations, the actors involved develop a common meaning and common practices. Then they also need to develop new indicators that serve the purpose to make the storylines sound right.

Because storylines provide a framework for thinking and action, the study of storylines overlaps with the various studies of frames and framing (e.g. Schön and Rein, 1994), only the difference being that storylines have a narrative status, indicating how things are going. For storylines about innovation, there is an overlap with Bijker's notion of technological frame (see Bijker, 1990) that refers to all elements that influence the interaction within relevant social groups and lead to the attribution of meaning to technical artefacts. These elements include: goals, key problems, problem-solving strategies, requirements to be met by solutions, current theories, tacit knowledge, testing procedures, design methods and design criteria. Within the concept of technological frame, all actors that are involved in the development of a technical artefact need to be included in the analysis, not only engineers (*ibid*).

The difference between the concept of technological frame and the concept of storylines involves the position of the actors who tell and act in the storylines. The first concept is a construct of the analyst to show that in the development of technologies heterogeneous groups shape this technology and attach significance to it. The second concept implies that storylines are actively constructed and narrated by the actors. As narrators are telling their storyline, they give themselves their own roles in the storylines, and thus create agency for niche formation and regime change. Of course, analysts can reconstruct storylines, as I will do, and when these appear to be dominant, they can use them to explain what actors are doing.

Manure and machines

photo M. Stuiver

Advertisement of manure and compost at farmyard

photo unknown

Broadcast surface spreading of manure on testplot

photo M. Stuiver

Manure application machine covered in snow

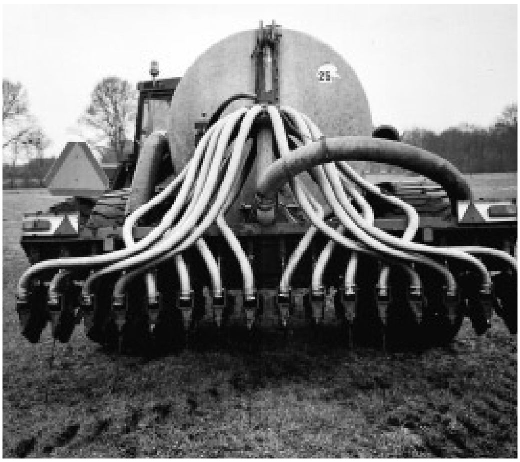


photo unknown

Shallow injection of manure

Projects

source Bioveem

Logo of Bioveem

source Koeien & Kansen

Pyramid of knowledge development and dissemination

source PMOV

Logo of Platform Minderhoudhoeve, Ossekampen, Vel en Vanla

source Noord Friese Wouden

Logo of North Friesian Woodlands

3. Too much bad manure! The development of the manure regime in Dutch dairy farming

'What a lot of dung is produced in the Netherlands. Incredible, all this shit. Imagine there are 16 million people in the Netherlands. Everybody shits one and a half ounce a day. That is more than 2 million kilos a day. Not to mention the animals! We have 13 million pigs, 100 million chickens and 4 million cows. Together, they shit more than 200 million kilos a day. And then there are the sheep and the horses and cats and dogs... and do not forget the wild animals! It is hard to imagine how much they shit per day. Together it is a mountain of manure that makes the Mont Blanc look like a small hill.' (Kromhout and Smaling, 2001: 4)

3.1. Introduction

This chapter[v] is about the development of the modern manure regime in Dutch dairy farming and the role of the accompanying knowledge infrastructure. At the centre of the debate about the environmental problems within dairy farming, the mountain of animal manure stands firm. Manure is used as an indicator of the importance of the environmental problems. There are tons of manure that have been produced during the past few decades and that find their origin in a dominant way of thinking and acting about manure: the manure regime in the Netherlands. This chapter discusses the three stages in the development of the manure regime within Dutch dairy farming. The first stage is characterized by a breakthrough in scientific insights, summarized as the 'Law of the Minimum', which became the basis of the modern manure regime. The second stage exemplifies the emergence and consolidation of the modern manure regime. The third stage is characterized by the reconsideration and opening-up of the modern manure regime. At the time I performed my research activities, the dominant manure regime of the 20th century already showed several openings.

3.2. Stage 1: The emergence of a new manure regime

This section describes the discovery of knowledge on manure and fertilization, which became the basis of the manure regime as it stabilized in the 20th century in the Netherlands. Knowledge about the use of manure to improve or secure the fertility of the land has not been evident through the ages. For instance, until the 15th century, farmers in the Netherlands did not use animal manure. They preferred to make use of fertile areas at the expense of the area's fertility. They exploited the land and then disposed of it, once it had gone barren (see Hudig, 1955).

It was only after the 15th century that farmers started to develop diverse kinds of technologies based on the use of animal manure. The use of animal manure was the most important means to increase the natural fertility of the soil (Rinsema, 1953). The productivity of the grasslands was determined by the amount of animal manure the farmers had at their disposal to apply to the grasslands. In order to obtain manure, the farmers kept animals at mixed farms. The farming system was almost a closed system, without many losses of phosphate and nitrogen (Kromhout and Smaling, 2001: 21).

At the beginning of the 19th century, the need for manure increased and different solutions were looked for. There was an increasing demand for agricultural produce so new ways of fertilizing were explored. Farmers spent a lot of time and energy on the acquirement of animal manure. At the same time, scientists started to look for other solutions to gain a larger supply of manure. Within the discipline of agricultural chemistry, influential scientists like Boussingault, Sprengel and Von Liebig started to develop novelties in the discipline of artificial fertilization (Van der Ploeg *et al*., 1999).

Let us take a closer look at Von Liebig, known as one of the early designers of artificial fertilization since Von Liebig's claims were the start for the development of a new regime of fertilization. Von Liebig published a book with the title: '*Die Chemie in ihrer Anwendung auf Agricultur und Physiologie*' (Von Liebig, 1840). In this book he formulated a theory that is considered to be the basis of artificial fertilization: the mineral theory. This theory postulates that different minerals contribute to plant growth. Sodium, potassium, magnesium, calcium, phosphor, nitrogen and sulphur all have their separate functions in plant growth. Von Liebig carried out several tests in his laboratory to build up evidence for his hypothesis. There was at least a period of twenty years of controversy around Von Liebig's theories (see Aikman, 1910). For instance, with his mineral theory, Von Liebig refuted the humus theory of Albrecht Thaer (1752-1828). The humus theory postulated that humus, which is a complex organic substance, formed the basis of the plant nutrients (Van der Ploeg *et al*., 1999: 155).[vi] The new regime was based on the postulation that plants do not feed on humus as Albrecht Thaer claimed, but on numerous mineral substances. These substances can be given to plants as artificial fertilizers.

Research on fertilizers expanded, not only in agronomic and chemical disciplines, but also in economic research. Between 1840 and 1870 several researchers tested Von Liebig's hypothesis and found support for his claims that mineral substances were the basic elements of plant nutrition. One of the discoveries involved super-phosphate. Von Liebig proposed to treat phosphate out of bones with the right amounts of sulphuric acid, which produces soluble calcium phosphate (see Hudig, 1955). Von Liebig also stated that when nutrients are dissolved in water, plants can grow. This formed the basis for the application of hydro-culture.

His (and Sprengel's) ideas are also called the 'Law of the Minimum'; yield is proportional to the amount of the most limiting nutrient. From this it may be inferred that if the deficient nutrient is supplied, yields may be improved up to the point that some other nutrient is needed in greater quantity, and in turn the 'Law of the Minimum' would apply to that nutrient. Von Liebig depicted a range of nutrients that can be conceptualized as a flexible range of growth factors. The nutrients literally became these factors that influence growth. Each growth factor describes an element within the production process that actually or potentially influences the yields obtainable within the process of production, for instance the quantity and composition of nutrients in the subsoil, the water availability or the plant variety. Together these growth factors determine the outcome of the process of production (Wit 1992: 43).

Von Liebig's 'Law of the Minimum' was the starting point of a new fertilizer regime based on the practice of artificial manuring. According to Von Liebig's theory, the use of animal manure was no longer the limiting factor for farm production. Plants could now be fed with a solution of minerals. Over the years, this view became dominant within agricultural research activities in the discipline of plant nutrition and farm production. Industries started to produce large quantities of fertilizers (Bieleman, 1996). At the end of the 19th century, fertilizer industries and phosphate industries expanded (Hudig, 1955). In the Netherlands, the use of fertilizer was stimulated during the second half of the 19th century because it was less expensive than animal manure (Bieleman 1996). This revolutionized modern husbandry (Aikman, 1910).

3.3. Stage 2: The stabilization of the modern manure regime in Dutch dairy farming

This section describes the stabilization of the modern manure regime in Dutch dairy farming. Important factors are the overall process of modernization and the roles of the state and other actors in this process. The development of the knowledge infrastructure that sustained this process of modernization is described, plus the epistemological views on science and innovation. Finally the specific impact on Dutch dairy farming and farm practices is explained.

The modernization process of agriculture in the Netherlands during the 19th and 20th century was geared towards the economic goal of maximizing the growth of productivity. The associated 'green' revolution resulted in several technological innovations in Dutch agriculture. The introduction of artificial fertilization was accompanied by other inventions in the fields of water management, mechanization and new plant varieties. The new technologies and their interrelations resulted in increases in yields (Schot *et al.*, 2000).

The Dutch government took responsibility for making sure that efficiency and productivity became the central points in agricultural production. There were strategic reasons: the reduction of food shortages and national independency in food supplies became more and more important, especially after the food shortages during the Second World War. Modernization of agriculture meant specialization and functionalization of various aspects of farming. The combination of increase in scale and modern (science-based) technologies was presented as the only route to success. The Dutch government aimed to reform the agricultural sector and to transform its working practices, farm structures and rural environments (Van der Ploeg, 1999).

In consequence of the process of modernization, the political decision-making started to involve much more actors. The government needed the Dutch farmers to be partners with the state. After the Second World War, a corporate organizational structure dominated the agricultural policy proc-

ess for almost forty years. The concept of the 'Agricultural Policy Community' (hereafter referred to as the APC) is used as a shorthand for this complex of stakeholders, relationships, policy processes, roles and objectives in the agricultural arena. Some authors refer to the APC as the 'Green Front' (Frouws, 1993: 15). According to Frouws (1997), members of the APC were leading farmers' representatives, experts from the *Ministerie van Landbouw, Natuur en Voedselkwaliteit* (Ministry of Agriculture, Nature and Food Quality, hereafter referred to as the Ministry of LNV), the *Landbouwschap* (Agricultural Board) and other corporate bodies in agriculture as well as members of the Parliamentary Committee on Agriculture. Members of the APC shared a common, firm, belief in technical progress and modernization. While contacts between the members of the APC were very close, any cooperation with the 'outside world' was rare. For instance, it was not until the 1980s that the APC started to consider regular contacts with the *Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer* (Ministry of Housing, Spatial Planning and the Environment, hereafter referred to as Ministry of VROM).
The corporate organizational structure was based on the aforementioned Agricultural Board, which was established in 1954. On this board, the three national farmers' associations and unions of farm labourers were represented. Until 1995, the Agricultural Board was both a platform for negotiation and a legislative body. In the latter function, the Board was entitled to levy taxes and to implement rules and regulations. The Board was the major negotiation partner of the Ministry of LNV.

The organizations participating in the APC were granted the privilege of influencing public policy-making in exchange for their cooperation, the legitimization of negotiated policies and maintaining discipline within their rank and file. Frouws (1997) states that this neo-corporatist exchange was 'ruled' by a permanent search for consensus, elitist decision-making, membership passivity and isolation from non-agricultural 'outsiders'. The APC was like a 'state within a state' and the Agricultural Board functioned as the 'farmers' parliament. The corporate structure worked effectively when the Ministry of LNV and the agricultural sector shared the same view of agricultural development: based on a highly productive, efficient, export-oriented agriculture, requiring farm expansion, specialization and intensification.

The intervention structure that was developed during this modernization process was characterized by an elaborate knowledge infrastructure (Grin *et al*., 2004), consisting of a web of institutions like the ministries and departments, research institutes, experimenting stations, extension services and farmers' organizations (Schot *et al*., 2003). The agricultural sciences were an essential part of the knowledge infrastructure since they were assigned the task to develop the innovations needed within agriculture. The state built an extensive and elaborate system of intervention, based on the linear model of innovation with a clear division of tasks; researchers develop the innovations, extension agents spread the innovations among the farmers who adapt the technologies to their local situation. Therefore, the knowledge infrastructure divided the farm into different sectors: food and fodder, milking, manure, economy etcetera. All these different sectors required research and development of technologies, techniques and artefacts. These different regimes (on food, on manure, on milking) reinforced each other in the development of modern farming. Research went hand in hand with the introduction of technologies and new codes of conduct and with the dissemination of these technologies and codes of conduct to the farmers (*ibid*).

One epistemological view on knowledge development became dominant during the development of the modern regime. Within the agricultural sciences, the epistemological view was based on logical positivism, which means that knowledge development should be based on the analyses and experiments carried out by neutral (or objective) scientists that produce theories on the basis of these analyses and measurements of facts. Laboratory experiments played an essential role in the agricultural sciences. Knowledge generated at laboratories is the outcome of (experimental) findings under controlled conditions. The scientists involved intentionally create boundaries between the laboratory and the outside world. The variability – inevitable in the outside world – that might otherwise confuse or hinder aggregation can now be managed in laboratory settings. In this *ceteris paribus* situation, manipulation of a selected group of variables will give an exact understanding of the effects of this manipulation. In this way, specific cause-and-effect relations can be identified and nomological knowledge (Koningsveld, 1976) is created. The conditions under which knowledge was developed, (the laboratory or research station) were translated to actual practice (in this case, the farm). The innovations developed at the research stations in controlled environments, and with easy access to inputs, were mainly useful to those farmers whose farming conditions were similar to the conditions at research stations and laboratories. Therefore, the conditions at the research stations (or laboratory) involved needed to be imitated implicitly.

Within the agricultural sciences, a specific view on innovation and the role of sciences became dominant. The basic opinion within the research tradition of 'adoption and diffusion of innovations' (Havelock 1969; Rogers 1962) was that innovations originate from scientists, are then transferred by extension agents and other intermediaries and are finally applied by farmers. This mode of thinking can be regarded as a follow-up of the linear model of innovation, since it describes a straight and one-directional line between science and practice. This dominant idea did not necessarily reflect the practices of the agricultural sciences (Van der Meulen, 1996).[vii] The farmers and their organizations also played an important role in developing knowledge and innovations.[viii] For example, researchers often got 'their' innovative ideas from farmers and farmers made significant adaptations to the packages developed by scientists. Furthermore, many innovations were realized without the involvement of scientists. The function of extension agents was not only to pass on knowledge and information from scientists to farmers, as it was often the other way around (see Richards 1985; Vijverberg 1997; Leeuwis 1993).

Within the modern regime, those who were successful in modernization were seen as 'vanguard' farmers and scientists (Van der Ploeg 1999). The guidelines for practices were not only described in manuals and magazines, but also in promotion films and instruction workshops. One example of intervention of the government in the farmer's manure practices is the development of the Manure Application Advice (Wieling *et al.*, 1977). The Dutch government intervened through setting up a system of extension that had to implement what were considered the best methods for applying fertilizer to increase grassland production. Over the years, the government supported the development of this Manure Application Advice (see chapter 7).

Dutch dairy farmers modernized their farms by focusing on the increase of production with the use of artificial fertilizer, fodder concentrates and maize. Apart from the industrial infrastructure that allowed farmers to increase their productivity, the political and economic infrastructures were geared to this productivity growth as well. Artificial fertilizer became the dominant input for stimulating grass or crop growth. Animal manure was regarded as a by-product and not as the most important source of nutrients. The farmer's argument: 'When I put enough fertilizer on my land, the grass will give the production I need.' The amount of artificial fertilizer that farmers applied to their grasslands increased from 75 kg/ha/year in the 1950s to 300 kg/ha/year in the 1980s (Bussink and Oenema, 1998). Apart from the use of artificial fertilization, another method became important in the second half of the 19th century: the purchase of fodder concentrates (Bieleman 1996). The farmers could easily purchase the bulk of fodder concentrates from the global industries, which were expanding as well, with Rotterdam as the central distribution centre. Cows were fed with excessive protein in fodder concentrates to ensure a high milk production. Furthermore there were changes in the composition of the fodder. One of the most significant changes was the disappearance of traditional crops like beets and clover after 1950. The widespread alternative was the production of maize.

When the use of artificial fertilizer, fodder concentrates and maize increased, the use of grassland as a source of fodder still remained important. For example; in 1980 the Netherlands had as much grassland as in the beginning of the twentieth century. One important change however involved the method of storage. The farmers developed their technologies to produce silage. Silage is produced by means of a conservation technology at which the fodder is fermented under controlled circumstances in a silo. In this way the silage can be stored and used for the animals in winter (Schot *et al*., 2000: 118). In silage production, the aim was to produce silage with maximum energy content (VEM) in order to be able to reach this high milk production. The production of silage was speeded up at the same time confinement housing and the milking tanks were introduced in the Netherlands (Schot *et al*., 2000: 117). Confinement housing resulted in a reduction of solid animal manure and an increase in slurry or liquid manure. As a result, the ways of manure application changed as well. Machines were developed that could spread the slurry over the grasslands (Bieleman, 1992: 314).

Several effects were visible at the level of dairy farms after the introduction of artificial fertilization and accompanying technologies. On the one hand, productivity (in grassland, milk and manure) increased enormously because of the introduction of fertilizer and concentrates (Bieleman, 1996). When the number of farmers decreased, the annual growth of livestock doubled between 1950 and 1980, in comparison to the hundred years before that (Schot *et al*, 2000: 150). On the other hand, the use of animal manure became less important and the production of manure was neglected.

However, the cows produced more and more manure and for a long time, no one considered this increase of manure production as a problem.

3.4. Stage 3: The manure regime revisited

This section deals with the environmental problems resulting from the manure regime and the new openings created. The societal debate created pressure on the problems the manure regime was faced with. This section also describes how the government amended the laws on volume policies and application policies. The associated knowledge infrastructure became scrutinized as well and led to a debate about the knowledge and innovation models that were needed to overcome the problems of the manure regime. This section furthermore describes how the government decided to set up new research projects on nutrient management.

The modern manure regime resulted in superfluous amounts of manure containing nitrogen (N), phosphate (P) and potassium (K). These elements created environmental burdens in various forms. Excessive nitrogen use has led to the accumulation of nitrates in the groundwater. Phosphates accumulate in the soil, and when the soil is saturated, it can leach into the groundwater and surface water. Leaching of nitrogen and phosphate results in eutrophication of surface water and the pollution of groundwater and has severe consequences in drinking water catchments' areas. Nitrogen is also an element of ammonia, one of the causes of 'acid' rain, which damages forests and ecosystems.

From the 1970s, societal pressure to reduce these environmental problems increased. A growing group of actors became concerned about the dangers of eutrophication and groundwater pollution (De Walle and Sevenster, 1998). As early as the 1970s, research reports from the National Institute of Soil and Fertilizer Research and the Institute for Soil Fertility indicated the negative side-effects of the excessive use of manure on agricultural soils (Bloemendaal 1995). From the mid-1980s, the Agricultural Policy Community could no longer ignore these signs.

The public interest in the environmental hazards caused by the high amounts of polluting manure created a crisis in the regime.[ix] The dark side of the modernization process, the ecological risks and threats to nature and mankind were becoming more apparent (Beck, 1992). Society was forced to regard itself as an issue and be a 'reflexive society', because of the dangers and hazards it had brought forward (Beck *et al*., 1994). As a consequence, more and more people realized that it was not possible to have total control of the environment, and that this modern assumption should be abandoned.

Government changes in application policies and volume policies

Environmental issues became important items on the political agenda during the 1980s, thanks to a stronger environmental lobby and a higher profile in public opinion. As a result the influence of the Ministry of VROM on agro-environmental policies increased. The first restrictions on production growth for environmental reasons were introduced in the 1980s after years of denial of these problems, obstruction of research and political struggles by the members of the Agricultural Policy Community (Bloemendaal, 1995).[x] From the 1980s, a new series of agro-environmental policy measures was introduced. According to Henkens and Van Keulen (2001) the approach was based on two lines of government intervention: application policies and volume policies.

The application policies involved a set of policy measures issued by the government. First there was the Decree on the Use of Animal Manure, which was based on the Soil Protection Act, regulating the application of manure between 1987 and 1998. It included specific restrictions on the annual dose of animal manure (i.e. the application standards).[xi] The application rates, determined on the basis of the phosphorus content of manure, were lowered in the course of time, to diminish the environmental impact of phosphorus and nitrogen.

The government also issued rules for the methods of manure application. Reduction of ammonia emission had to be achieved through application of manure with emission poor technologies. Important documents that led to this legislation were the EU Nitrate Directive and the EU Water Directive (EC 1991; EC 2001). The government initiated the development and testing of several methods of manure application like narrow band manure application, shallow application, manure injection and shallow injection. In 1995, the Ministry of LNV decided to allow emission-poor technologies only. It became obligatory to inject the manure into the soil (Ministry of LNV, 1998). From that moment, broadcast surface spreading was forbidden in the Netherlands. The government based this decision on calculations of the emission reduction of the different technologies compared to broadcast surface spreading. Wouters (1995) describes the emission reduction in percentages (Wouters, 1995).

Table 3.1. Emission reduction for different methods of manure application (Wouters, 1995)

Method of application	**Emission reduction (%) compared to broadcast surface spreading**
Broadcast surface spreading	0
Narrow band application	50-80
Shallow application	> 80
Manure injection	>95
Shallow injection	>95

In order to formulate this law, the Ministry of LNV conducted several studies. For instance, together with the Ministry of VROM and the province of North Brabant, a study was carried out in 1989 in order to test shallow injection of manure in actual practice. The study focused on the implementation of the methods in farmers' practices. A committee monitored the development and the results.

This committee included a farmer, an extension worker, a grassland scientist and a manure scientist. One of the conclusions of this research was that shallow injection of manure can easily be applied to large areas of grassland and requires a good organization of manure deposits (see Anonymous, 1989).

The volume policies included regulations on the volume of manure. They initially aimed at putting a stop to the expansion of the livestock sector and thereby the increase of manure surpluses at a national level. This started with the introduction of the Interim Pig and Poultry Holdings Act in 1984. In 1987, this Act was replaced with the prohibition of expansion and disposal of manure production. Since 1994, new conditions for the disposal of manure are specified, as part of the Disposal of Manure Production Act. This provides a set of rules and regulations referred to as the System of Manure Production Rights. Thus in the early 1990s, the rules regulating manure production aimed to achieve a national balance between production and disposal of manure.

The integration of application policies and volume policies was an uphill battle and additional policies were needed. In the course of the 1990s, it became evident that curbing the volume of manure production could not guarantee a national balance between production and disposal, since increasingly tighter manure application standards that were issued as a result of the application policies, made this harder to achieve. Furthermore there was the need to comply with the EU Nitrate Directive. As a consequence, additional policy measures became necessary. According to Henkens and Van Keulen (2001) it became more and more clear that an effective manure policy required a system that took into account the large differences in manure surpluses, between different sectors and different regions.

In 1998, the *Mineralen Aangifte Systeem* (Minerals Accounting System, hereafter referred to as MINAS) was introduced as a 'central instrument for restricting nutrient surpluses'. MINAS implied a completely new approach to manure policies (Siemes, 2001):

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

The last change was only partially true, since the restrictions on the allowed times and methods (e.g. obligatory slit injection of manure) remained in force alongside MINAS. Compliance with MINAS implies that all farmers were obliged to register the annual inputs of nutrients in livestock manure, organic manure, chemical fertilizer, roughage, concentrates and nitrogen fixation, as well as the outputs of nutrients in agricultural products (milk, meat, crops, and roughage) and in animal manure. These figures provided the basis for calculating nutrient losses per hectare (at the level of the individual farm). In order to comply with the EU Nitrate Directive, MINAS set standards for losses (see table 3.2.).

Table 3.2. Loss standards for phosphate and nitrogen in kg per ha per year (Siemes, 2001)

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

However, early October 2003 the European Court of Justice, in a case brought against the Netherlands by the European Commission, ruled that the Dutch system of rules and regulations (in particular MINAS) did not guarantee an adequate or timely realization of the requirements of the EU Nitrate Directive. From that time, the Dutch government had to apply the European excretion norms.
The application policies remained part of the Dutch regulations.

New openings in the knowledge infrastructure

After the seventies, more attention was paid to the role of the knowledge infrastructure in changing the modern manure regime. Within the agricultural sciences, debates started to emerge that reflected on the underlying assumptions on science, knowledge and innovation generated by the knowledge infrastructure. There was an increased interest in experimenting with research into other types of agriculture, e.g. organic farming. Part of this experimentation would involve the development of new methodologies and new forms of scientific production. There was also an increased interest in innovations in which farmers' knowledge would play a role.[xii] More and more actors within agriculture started to view innovation as a non-linear process, which involves many actors. (Leeuwis *et al*., 2006).[xiii] Scholars within the social sciences pointed out the need to relate knowledge to specific socio-spatial environments, in order to realize sustainability (see Clark and Murdoch, 1997; Kloppenburg, 1991).[xiv]

The Minister of LNV consulted the *Nederlandse Raad voor Landbouwkundig Onderzoek* (the Dutch Council for Agricultural Research, hereafter referred to as NRLO) for advice. In 1997 the NRLO produced a report on the potential of organic farming for modern agriculture. The NRLO distinguished two contrasting views in the agricultural sciences: the first being the approach of Von Liebig and the second being the approach of De Wit; the natural science approach and the organic approach. The NRLO advised the Ministry to give more room to the organic approach; including the aspects of animal welfare, environment, nature and landscape. The dominant ways of thinking and vested interests of the regime at that time would not allow enough space for these aims. Wageningen University and Research Centre was asked to pay attention to methodologies that would operationalize innovative concepts (Nationale Raad voor Landbouwkundig Onderzoek, 1977). Two new initiatives followed. The first was the temporary Department of 'Alternative methods in agriculture', with Professor Van Mansvelt as head of department. The second was the establishment of an experimental farm that focused on the development of farming systems, later on called the A.P.Minderhoudhoeve (hereafter referred to as APM). In 1996, the NRLO produced another report that focused on new scenarios for the agricultural sciences, including new forms of scientific production (van der Meulen 1996).

Research based on a more organic approach gained new attention after the seventies. Organic farming is a sector in farming that has created an alternative to modern agriculture alongside the modernization process.[xv] The basis of organic farming is that one starts with the soil. Rephrased in terms of Von Liebig's growth factors: within organic farming artificial growth factors (and especially those related to external inputs) play a very small role or no role at all. Within organic agriculture, greater emphasis is put upon internal rather than external growth factors. Local ecological conditions and locally available growth factors need to be the starting point for reaching sustainable balances.[xvi]

Research into organic agriculture considers farmers' knowledge as a valuable resource alongside scientific knowledge. One of the pioneering research institutes within the field of organic farming in Europe is the Louis Bolk Institute that aims to develop organic farming based on farmers' knowledge and inventions. The research practice at the Louis Bolk Institute is based on 15 years of research experience and mutual learning with farmers in the field of organic dairy farming (Baars, 2002). Baars argues that organic farming relies much more on management skills than on technical adaptations. Therefore the top-down innovations and standardizations become less relevant. The development of organic farming therefore should rely on a learning situation in which farmers can experience new ways of action (Baars, 2002). In view of this, local and specific knowledge about the farm and its environment acquire a new relevance. Since farmers are important carriers of such knowledge, it is not surprising that the issue of farmers' knowledge attracts more attention within organic farming (Baars and de Vries, 1999).

The development of nutrient management projects

Apart from investing in organic farming, the Dutch government also decided to initiate several projects on nutrient management. The nutrient management projects aimed at developing sustainable farming practices in the Netherlands according to the norms set by Minas (see table 3.2.). These nitrate projects (in Dutch: *nitraatprojecten*) were set up to gain knowledge and explore management options for farmers to meet the sustainability demands set by the national government (see Anonymous, 2000b; Ekkes and Horeman, 2004). The various projects aimed at developing and disseminating innovations in nutrient management in the agrarian sector; it included the improvement of the farming systems and farm management as well as the increase of nutrient-use efficiency and optimization of animal manure. Three types of projects were developed. The first type involved national research projects, the second type national demonstration projects and the third type involved regional projects.

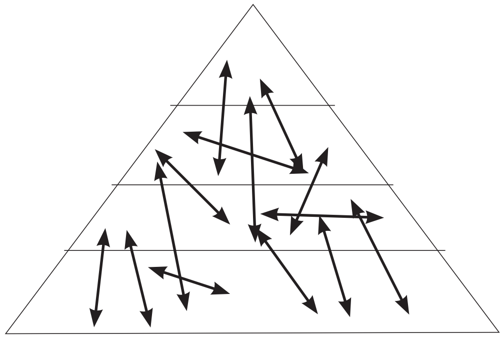


Figure 3.1. Pyramid of knowledge development in experimental farms, pioneer farms, demonstration farms and agricultural sector (Ekkes and Horeman, 2004: 7)

The different projects were organized from a specific view on knowledge development based on the model of 'diffusion of innovation', translated into figure 3.1. The top and second layer of the pyramid represent the development of innovations on experimental farms and pioneer farms (the early innovators) that focus on knowledge development and research in nutrient management. Research activities are considered the responsibility of early innovators at the top of the innovation pyramid. The third layer of the pyramid represents the 'early adopters' that have an important role in the diffusion of knowledge towards the rest of the agricultural sector (the fourth layer of the pyramid).

Another distinction is made between national and regional projects. National research projects develop new knowledge and perform research. National demonstration projects focus on knowledge dissemination throughout the country. They are closely connected to the experimental farms and early innovators of the national projects. Examples of national research programmes are *Koeien en Kansen and Bioveem*; national dissemination programmes are *Praktijkcijfers* and also *Bioveem*. Regional projects were classified to disseminate the information about nutrient management to the regions. The task of the regional projects also was to increase the number of early innovators in the sector and to look for regional opportunities for nutrient management. One of this projects that was financed from 2001 onwards as a regional project was the Nutrient Management Project of VEL and VANLA located in the Frisian Woodlands.

One of the experimental farms was *de Marke*, established in 1992. At *de Marke* experiments were carried out that involved too many risks for the individual farms in terms of income, for example on grassland performance. The scientific research at *de Marke* involved a wide array of issues, for instance the possibility of finding scientific indicators for soil and manure quality. Manure application technologies were researched as well. The results of *de Marke* were compared with the results of the farms of *Koeien en Kansen*. For example, when the farms could not meet the norms of the national government, this could be compared with the results at *de Marke*, to find the crucial differences.

Koeien en Kansen was a national project financed by the Dutch Ministry of LNV. It started in 1999 and lasted until 2006. Its goal was to research the effects and implementation of the national targets for ammonia emission and nitrate leaching at the level of the individual farms. During the project, the agricultural scientists involved had to realize an extensive registration of all the data from the observed farms that were involved. The farms that were selected were located in different regions in the Netherlands, with different soil types. The first aim of *Koeien en Kansen* was to be a scientific project to monitor the consequences of the national measures on nitrate leaching and ammonia volatilization. The second aim of the project was to function as a demonstration project for farmers in the Netherlands. Sixteen farmers all participated in study groups and set up their own regional study groups. Seven farms of the sixteen dairy farmers involved and the experimental station *de Marke* were the locations of the experimental research that took place, with an intensive scientific monitoring. The other nine dairy farms focused on knowledge dissemination through the set-up of regional networks or study groups. Their main function was to communicate and spread the innovation to a wider group of farmers. In this way, the information was supposed to spread among a large group of Dutch farmers.

Bioveem was a national project that started in 1997 and lasted until 2006. It aimed at enhancing innovations and knowledge development for the organic dairy sector in the Netherlands. Therefore the research questions dealt with technical, socio-economic and ecological matters. The project wanted to contribute to the national target of ten% organic agriculture in the Netherlands. *Bioveem* aimed at upgrading the existing innovations that were present at farm level. They did this by differentiating 3 groups of farmers and by giving these three groups specific support in knowledge development. The first group was called the pioneers; dairy farmers that had already committed themselves to organic farming for a long time. According to the project, they were the pioneers because they had shown to be ready to take risks and they had many questions to solve. The second group involved organic dairy farmers who had an open attitude to organic farming and were willing to generate knowledge together with the pioneers and learn from them. The last group was composed of dairy farmers that had chosen to convert to organic farming. They were given personal assistance in learning new skills. They participated in study groups with organic farmers from the second group and the first group. In this way, the knowledge from the first and second group got spread among a larger group of dairy farmers in the Netherlands.

Praktijkcijfers I started in 1997 and lasted until 2001. It was a national demonstration project with the aim to reach as many farmers as possible. Dairy farmers performed the necessary actions to reach the sustainability targets and demonstrated this to other farmers in the sector. *Praktijkcijfers II* lasted from 2000 until 2003 and focused on the implementation and development of the so-called ´Good Agricultural Practice´ concerning nutrient management among many farmers in the Netherlands (see below).

The overall aim for the innovations that were developed within the nutrient management projects was to achieve a 'Good Agricultural Practice' ('in Dutch: *Goede Landbouw Praktijk*). Dutch farmers were challenged to perform a 'Good Agricultural Practice' (Ekkes and Horesman, 2004: 19) and could achieve this by aiming for the goals set by the government. These goals were the nitrogen loss standards that were set by MINAS (see table 3.2.). The nutrient management projects dealt with these goals in two ways. First of all, research was done in the national research programmes to develop and gain an understanding of what this 'Good Agricultural Practice' would imply for the management of the dairy farms. Secondly, farmers in the Netherlands were supposed to implement these guidelines of the 'Good Agricultural Practice' in their farm management in order to achieve the desired sustainability demands. The implementation of the guidelines was organized by the national and regional dissemination groups, based on the model of 'diffusion of innovation'.

3.5. Conclusions

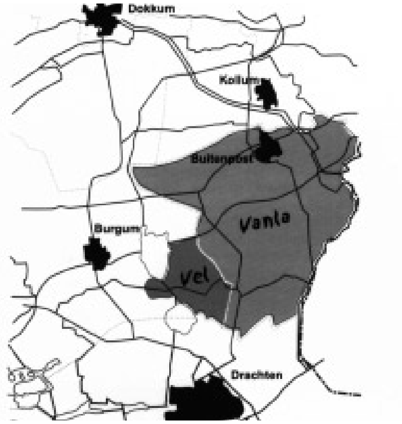
During the modernization of Dutch dairy farming, the development of the manure regime was embedded in the overall modernization of agriculture; aimed at the maximization of primary production. The ´Law of the Minimum´ became the basis of an agriculture that was based on the use of high amounts of fertilizer and concentrates. Animal manure was of low value and was seen as a waste product. The intervention structure that was developed during modernization was characterized by an elaborate knowledge infrastructure composed of a web of institutions like the Ministry of LNV, research institutes, experimental stations, extension services and farmers' organizations. The epistemological stance underlying the knowledge infrastructure was based on logical positivism, which means that knowledge development should be based on the analyses and experiments carried out by neutral (or objective) scientists that produce theories on the basis of the analyses and measurements of facts performed in laboratory experiments.

The issue of nitrogen pollution of groundwater and ammonia volatilization became a part of the political discourse during the environmental crisis (Hajer 1995). The crisis in the manure regime created several openings. The national government issued new application policies and volume policies. New lines of research were set up, for example research into other types of agriculture, like organic farming. Part of this new research agenda would involve the development of new forms of scientific production. There was also an increased interest in developing new knowledge and insights into nutrient management in the so-called national 'nitrate projects'. A wide range of projects emerged at which farmers and scientists started to experiment with nutrient management. These projects were based on the model of 'diffusion of innovation', in which farmers played a role as 'innovators' and 'early adopters' (Rogers, 1962) of the new guidelines for 'Good Agricultural Practice' in nutrient management.

Landscape

photo M. Stuiver

Grasslands surrounded by belts of trees



source NLTO

Overview of Vel and Vanla area and the environmental cooperatives

The Netherlands and Friesland

photo M. Stuiver

Walking trail through farmland in Eastermar

Meetings

source unknown

Scientist Van Bruchem and Reijs obtain manure from a manure application machine

photo J.Groot

Farmers and scientists meet in farmer's kitchen

source LTO

Scientists Stuiver and Reijs prepare interviews with farmers

source unknown

Studymeeting Vel and Vanla in Eastermar

4. The rediscovery of making good manure, the case of the Nutrient Management Project of VEL and VANLA

4.1. Introduction

This chapter[xvii] describes the rediscovery of making good manure through the prism of the Nutrient Management Project of VEL and VANLA. The chapter describes how the participating farmers and scientists started to experiment with finding new ways out of the manure regime at that time. The chapter gives an analysis of the ways the actors attached significance to their activities via the narration of shared storylines. In section 4.2., the Nutrient Management Project and my role as a researcher are introduced. Section 4.3. focuses on the start of the Nutrient Management Project. Section 4.4. deals with the novelties that the actors decided to investigate to solve the problems with manure in dairy farming. Section 4.5. describes the research activities that the actors carried out to make their novelties more robust. Section 4.6. describes the processes of alignment and mobilization that took place among the actors in creating common meaning in the novelties they developed. Section 4.7. focuses on the ways the members started to share common storylines within the Nutrient Management Project. Section 4.8. contains the conclusions of the chapter.

4.2. Material and methods

This chapter is based on my participation within the 'VEL and VANLA Nutrient Management Project' in Friesland in the Netherlands, which took place between 1999 and 2004. The central question of the Nutrient Management Project was how to improve the dairy farming systems in such a way that the surplus of nitrogen emitted in nitrate and ammonia could be decreased (Verhoeven *et al*., 2003; Verhoeven, 2000). Farmers of the environmental cooperatives worked together with a heterogeneous group of scientists. Two platforms were set up in which farmers and scientists exchanged information and learned about their activities: the research council and the study meetings.

During my research, I made use of a variety of methods. First of all, I participated in a sequence of activities, like the research councils and the study meetings. I observed the different actors and their contributions to the meetings and I held unstructured interviews to discover their contributions to the project.[xviii] During the research council meetings, I noted down the statements and the opinions of the different members. During the study meetings, I focused on the interactions between the farmers and researchers in understanding and interpreting the experiments. I also focused on the views on knowledge they expressed. Secondly, I interviewed the actors involved in the project (i.e. the scientists, the farm leaders and the farmers of the Nutrient Management Project) and I worked with them. I visited the farms of the farmers involved and I also visited the research plots that were developed on two of these farms. I did this to get a clear view of the expertise developed in the Nutrient Management Project. Thirdly, the project leader of the Nutrient Management Project became a vital informant. Everyday, I kept in touch with him to find out what was going on in the project, not only the positive things, but also the challenges he was confronted with. Together with this project leader, I made a collection of the documents and reports written during the project, plus the publications on the subject. Finally, I also deepened my understanding of the different aspects of manure and the types of expertise involved, like soil science, animal science, farming systems research and manure application technologies. I analysed the relevant documents to understand the knowledge claims the participants made and the ways in which the various participants construed the evidence needed to support the emerging storylines in the Nutrient Management Project.

4.3. The start of the Nutrient Management Project of VEL and VANLA

In October 1999, animal scientist Van Bruchem and I went to The Hague, to visit a delegation of the Dutch Parliament. Van Bruchem was going to present his solutions for the problems caused by the high production of animal manure in Dutch dairy farming. His view is that Dutch farmers produce bad manure, since it contains too much nitrogen and is therefore bad for air and water.[xix] A lot of sustainability problems in dairy farming could be solved if the farmers would discover new ways to increase the efficiency of their own resources like manure, soil and fodder and start making good manure. In his opinion, good manure can be achieved by changing the diet of the dairy cattle towards fibre-rich and protein-poor rations. He explained that fibre-rich and protein-poor rations will increase the efficiency of nitrogen use in the total farming system, while the same levels of milkproduction will be maintained.

He described his own scientific biography in terms of a paradigm shift. In his words: ‘In former times I used to think as a reductionist scientist that tried to increase nutrient use by the animals. The shift in thinking took place when I visited farming systems in Indonesia, where farmers put the emphasis on the total farming system.’ After his return to the Netherlands, he became a known figure within the scientific community because of his critical attitude towards the ‘nitrate projects’ established by the Dutch government (see chapter 3). In his opinion, the projects focused on the wrong solutions for the environmental problems and instead they should pay full attention to increasing the nutrient efficiency of the total farming system. This should be the starting point for their research activities (van Maanen, 2003b). He also started to criticize government measures like emission-poor stables and emission-poor manure application. According to Van Bruchem, these measures do not have the desired result. In his opinion, ammonia emission is caused first and foremost by protein-rich rations, which result into manure that is produced with too low a C/N ratio[xx], with many toxic components and a negative effect on the soil (Van Bruchem *et al*., 1999a).

One week before that, he had already taken me to the experimental farm APM in Swifterbant (Kattenberg, 1989). At this farm, a mixed farming system was set up to test the possibilities of increasing the nitrogen efficiency within the total farming system (Lantinga and Van Laar, 1997). At that time, Van Bruchem conducted research that focused on the effects of dairy cattle diet on the quality of manure (Hylkema, 1999). Some of the first results of the APM seemed to be promising, so he started to look for farmers who wanted to test his hypotheses in actual practice (Wesselink, 1999). He stated; 'I thought: test my strategy in the integrated context of the farm and try to produce statistical evidence for it. I want to translate the measurements into a project, how does it actually go?'

During our trip to The Hague, Van Bruchem told me about a meeting two years earlier, where he met Professor of Rural Sociology Van der Ploeg. Van Bruchem told me that he invited Van der Ploeg to cooperate in the development of novelties on making manure in dairy farming. Van der Ploeg already had extensive contacts with the Frisian farmers dating from preceding work at his Department of Rural Sociology at the Wageningen University (Bruin, 1997; Bruin and Van der Ploeg, 1990). He was actively involved in the establishment of the environmental cooperatives and supported the negotiations between the farmers and the Dutch government about the governance experiment (Stuiver and Wiskerke, 2004).

Van der Ploeg's interest in the farmers in the Frisian Woodlands was a combination of a couple of his academic interests, i.e. the discovery of farmers' knowledge (Van der Ploeg, 1993b); the limitations of the agricultural expert systems (Van der Ploeg, 1999) and the existence of various practices, which he conceptualized with the term 'farming styles' (*ibid*). Van der Ploeg's argument was that the agricultural regime was the cause of many problems in agriculture. In his opinion, the role of science was crucial. The expert system, as Van der Ploeg called it, had based legislation on simplified models of productivity gains and intensification of agriculture and not on a diversity of farming practices. In his opinion, in order to find solutions for the crisis in the manure regime, one needed to acknowledge diversity in farming practices. Furthermore, it was especially worthwhile to investigate the solutions for the future that were present in marginalized and tacit practices. He argued; give farmers and their various practices a larger role in knowledge production, because in actual practice the solutions are already present. Science needs to develop these often tacit novelties that are part of these farming practices instead of denying or frustrating them.[xxi]

Van der Ploeg knew one of the farmers of the VANLA environmental cooperative very well. His name was Hoeksma, a farmer from Drogeham in the Frisian Woodlands. Hoeksma belonged to a group of twenty farmers that got permission to continue with broadcast surface spreading of manure from 1994 onwards. Hoeksma integrated his own observations and management decisions at farm level.[xxii] For example, he had closely watched the condition of the grassland and the soil for 40 years.

One day, Hoeksma showed Van der Ploeg an overview of the period 1955-1995. He wondered at the fact that until 1965 the organic nitrogen (Norg) content of his grassland was constantly around 11%. However, when Hoeksma built a cubicle stable[xxiii] in the 1970s, the Norg content of his soil decreased. Since he did not plough or otherwise intervene in the grassland, he supposed that the change in (slurry) manure quality was the cause of this, because of the introduction of the cubicle stable. His hypothesis was that the animal manure contained a different content of both nitrogen and other substances. In his words: 'The quality of my manure decreased and this had an effect on the Norg content of my soil.'

In the beginning of the 1980s, Hoeksma started to add additives to the manure. Basically there are two kinds of additives, Effectieve Micro-organismen (Effective Microbes, hereafter referred to as EM) and Euromestmix (Euromanure mixture). EM is a mixture of microbes. It is supposed to increase the microbe activity in manure, soil and plants (Higa 1998). Euromanure mixture or Agrimest is composed of clay minerals. At that time, Hoeksma started to add Euromanure mixture to the manure. The clay minerals were supposed to bind the nitrogen, so that the ammonia volatilization of the manure decreases. He stated that the Norg content of his soil was returning to normal levels again (Van der Ploeg, 1999; Verhoeven *et al*., 2002).

In 1997, Van der Ploeg, Van Bruchem and Hoeksma exchanged their ideas and observations. They met each other, in the hope of starting a nutrient management project with neighbouring colleagues of Hoeksma in the Frisian Woodlands. During 1998, the farmers and scientists started to negotiate with various stakeholders, like the Province of Friesland and Wageningen University, to obtain finances for establishing a nutrient management project. Van Bruchem wanted to test his ideas on the relation between dairy cattle diet and manure quality, in cooperation with a group of farmers. Hoeksma wanted to research the relations between manure quality and Norg content of the soil. He also wanted to know more about experiences with additives. Van der Ploeg was interested in farmers' knowledge and the potential novelties that were hidden in the farmer's practices of the environmental cooperatives.

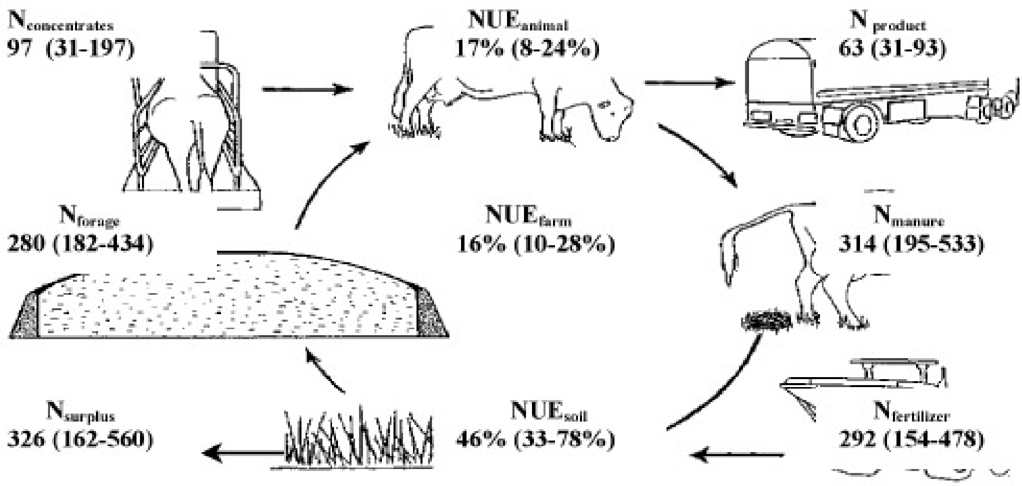


Figure 4.1. Average, minimum and maximum N flows (kg N ha^{-1} year $^{-1}$) and efficiencies (%) of 93 farms in the VEL and VANLA area in 1995/1996 (after Reijs et al., 2004; 22).

In 1998 they decided to draw up the nitrogen balances[xxiv] of 93 VEL and VANLA farms, based on the period from May 1995 until May 1996 (Verhoeven *et al*., 1998). Van Bruchem proposed to look at the nitrogen flows from a systems perspective (see figure 4.1.). The question was: what are the N flows and N efficiencies of the total farming system? What were the losses and what was the nitrogen use efficiency per farm? From these balances, it became evident that there were huge differences in nitrogen flows (and in nitrogen use efficiency) among the 110 farms (with an average ranging between 10 and 28%).

After discussing these findings, the scientists decided that they wanted to have a better understanding of the farms that showed to have lower nitrogen losses. The hypothesis they formulated was that the total loss in nitrogen within the farming system could be effectively reduced. Moreover, nitrogen use efficiency in the plant-soil system varied more among the farms (between 33% and 78%) than nitrogen use efficiency in the animal (between 8% and 24%). This observation suggested that there is more to gain from increasing the nitrogen use efficiency in the plant-soil system than in the animal (Verhoeven *et al*., 1998). The leading question now was: how do some of the farmers within the VEL and VANLA cooperatives achieve high nitrogen use efficiency in the total farming system? What can be learned from their experiences?

In 1998 and 1999, Van Bruchem and his colleague Verhoeven[xxv] started visiting the farmers of the environmental cooperatives. They visited farmer Hoeksma and farmer Benedictus (the chairperson of one of the cooperatives) and asked them which farmers would be interested and suitable to join a possible scientific project. Therefore they organized a series of study meetings. They explained to the farmers present that they wanted to start a project focused on novelties to increase the nitrogen efficiency.

The Nutrient Management Project of VEL and VANLA started with establishing the first experimental group of twenty farmers; the Euromanure mixture group. These farmers were involved in the activities to increase nitrogen use efficiency from the beginning and they calculated their nitrogen balances from 1992 onwards (see section 6.4. for an elaborate discussion). This group of farmers was allowed to use broadcast surface spreading since 1992. Therefore these farmers were already working on the improvement of the efficiency of their own manure. Members of this group included Bloemhof (see chapter 5) and Hoeksma (see Verhoeven *et al*., 2002.[xxvi]). As they were looking for cooperation with others to gain a better understanding of their experiment, they found Van Bruchem's ideas attractive, as demonstrated by the next recollection of one of the farmers: 'We could not continue farming within the prevailing policies of the government. The ideas of Van Bruchem about the importance of the nitrogen cycle within the farming system made a lot of sense to us at the time and we decided to work on the soil-plant-animal system together with the researchers.'

At a second meeting, Verhoeven and Van Bruchem offered other farmers within VEL and VANLA the opportunity to participate in the Nutrient Management Project. The second group was a group of twenty farmers called the EM group, who sprayed EM on the grassland but were not allowed to use broadcast surface spreading. The last group was the control group of twenty farmers who did not use any additives and were not allowed to use broadcast surface spreading. In October 1998, the first series of study meetings between these 60 farmers took place. Twelve groups of five farmers were formed that decided to meet on a regular basis. The Nutrient Management Project of VEL and VANLA had taken off in the area.

4.4. The formulation of the promising novelties

During the research council meetings in 1999 and at the beginning of 2000, a selected group of farmers participated in the formulation of the novelties that would be explored and tested during the Nutrient Management Project of VEL and VANLA. The novelties were formulated together with the participating researchers (Verhoeven, *et al*., 2003a). Hoeksma, Benedictus and Bloemhof were regarded as representatives of these farmers and therefore they were in close contact with the researchers in the research council and during study meetings.

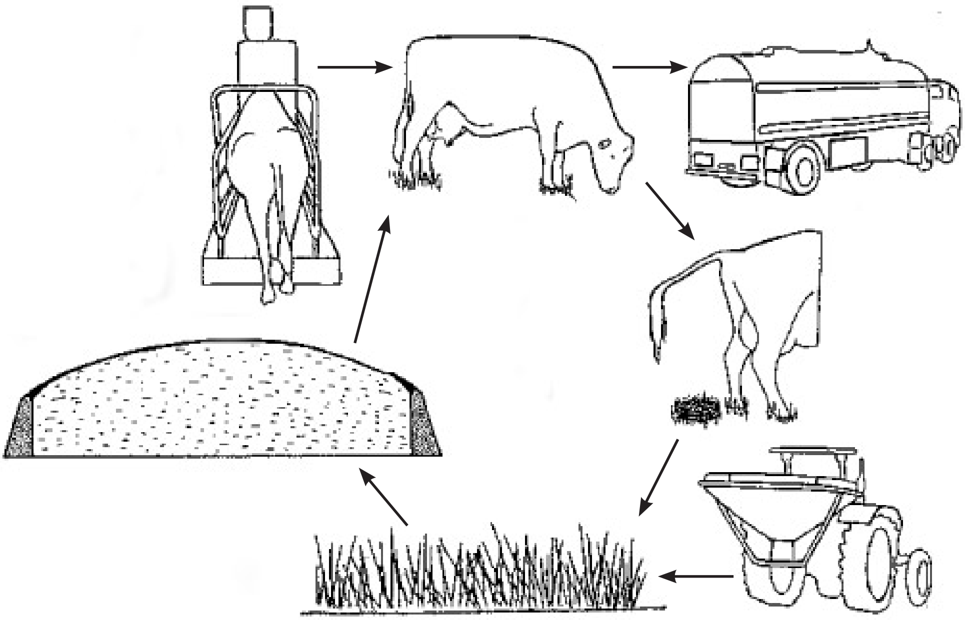


Figure 4.2. The soil-plant-animal system of the Nutrient Management Project of VEL and VANLA

From the beginning, a diagram (see figure 4.2.) was used as the basic guideline of the Nutrient Management Project. The diagram depicted the soil-plant-animal system interactions, a pattern of linkages within a dairy farm (Verhoeven *et al*., 2003d). Verhoeven and Van Bruchem drew the first diagram in 1998, to assist the other farmers in understanding how they could improve nitrogen efficiency at a farm level. The aim was to achieve a systematic and integral reorganization of the production process in order to create a new balance that allows for farming being both ecologically and economically sustainable. The soil-plant-animal system highlighted the existence of the different, relevant subsystems; cow, manure, soil and plant. All these relevant subsystems needed to be reorganized in such a way that a new equilibrium could be created (Van Bruchem and Tamminga, 1997). The soil-plant-animal system was also called the systems perspective, since it highlighted not just one element (the cow) but all the relations within the total farming system.

Van Bruchem, Verhoeven and the farmers formulated a set of novelties that would adapt the soil-plant-animal system to the specific experiences and knowledge of the farmers in the Frisian Woodlands. The promising novelties they decided to investigate were: 1. Experimenting with a lower fraction of mineral nitrogen (Nmin) in the manure (Reijs *et al*., 2003); 2. Finding evidence that broadcast surface spreading has a positive effect on soil structure and soil life and 3. Using additives.

Strategy 1: Experimenting with a lower fraction of Nmin in manure

The farmers wanted to experiment with reduced fertilizer inputs, but this was not the most important step they wanted to take. The reduction of nitrogen should be dealt with at the source, namely by improving the animal manure that is produced. During a study meeting at the APM farm in October 1999, the farmers stated they wanted to experiment with making manure that contained a lower fraction of Nmin. The reason for this is that they thought that the potential amount of nitrogen that volatilizes depends on the amount of Nmin in the manure.

The farmers wanted to influence on purpose, as they called it, 'the quality of manure' and by doing so, reduce the ammonia volatilization. During the study meetings, the farmers made a distinction between the qualities of different kinds of manure. They differentiated thick manure and thin manure, good manure and bad manure, ugly manure and beautiful manure. It was important to make that distinction and to compare their manure with the manure of the past.

During the study meetings in 1999, Van Bruchem proposed to focus on a different composition of the diets to make manure (Van Bruchem *et al*., 1999a). The hypothesis was that a change in the composition of the diet towards less crude protein (RE) and less surplus protein (OEB) would enhance the conversion of nitrogen from feed into nitrogen into milk. An increase of dietary fibre (RC) was promoted to stimulate rumen functioning and hindgut fermentation. Increasing the amount of RC was also supposed to increase the organic nitrogen (Norg) of the manure. These adjustments were expected to lead to changes in manure composition with a higher C/N total ratio, lower mineral N contents (Nmin) and a larger proportion of Norg, less susceptible to losses through volatilization and leaching (Reijs *et al*., 2004).

One important indicator to measure the effects of the use of fibre-rich and protein-poor diets was the carbon-nitrogen ratio (C/N ratio). The C/N ratio in manure depends on the amounts of protein and fibre (which contains C) used in the feed and fodder (Lantinga and Van Bruchem, 1999). Increasing C/N of the slurry implied a change in the cows' diets, reducing the amount of protein and increasing the fibrous content. In addition, straw was added to the slurry and some farmers used additives which were expected to further improve the C/N ratio (Reijs *et al*., 2004).

The farmers started to experiment with dietary adjustments and grassland management. From the first findings at the experimental farm APM (Hylkema, 1999) specific guidelines were formulated for grass silage composition at the VEL and VANLA farms. These guidelines were summarized as follows (Benedictus *et al*., 2001): a decrease of RE and an increase of sugar and starch (to have sufficient amounts of energy for milk production). Finally a decrease in OEB and an increase in RC were aimed for. This was done through postponing the first silage cut in spring.

The farmers and scientists developed an understanding of indicators that could serve as tools to manage this good manure and to compare the different farm results. The following indicators became important: Good manure is manure with a high C/N total ratio, which implies a lower amount of Nmin and a higher amount of Norg. This manure should not be too thin and should be ripened. Manure that contains less Nmin is manure that does not smell. This manure is made via a ration with lower RE and OEB in the silage and a higher RC and sugar content in the silage.

From 1999 until 2002, data were gathered of the composition of the silage of the first mowing period. The farmers exchanged and compared the findings with each other in the study groups. The relation between grass quality and fodder quality was analysed as well and together with fundamental knowledge about grassland management, it was the subject of a workshop about grassland and feed in April 2003 for farmers inside and outside the Nutrient Management Project

Strategy 2: Experimenting with manure application

During study meetings in 2000, it became clear that the farmers wanted to know more about the ways they could influence ammonia volatilization and mineralization processes. Increasing their expertise on applying manure was important to them and they wanted to experiment with this. Nitrogen in manure consists of Nmin and Norg. Nm is directly available to plants but is also more susceptible to volatilization. Norg has to be mineralized by soil microbes before it is available to plants. This last process was something the farmers wanted to know more about.

Therefore the farmers wanted to develop insights into the effects of technologies of manure application. Their expectation was that shallow injection would lead to lower nitrogen use efficiency, because of the harm done to the soil structure and to soil life. This makes that Norg in manure is less available to plants. In their opinion, this resulted in negative consequences for the total nitrogen efficiency. ‘Shallow injection is bad for soil life like earth worms, and soil life is important for the nitrogen delivery capacity, so it could well be that shallow injection has an influence on the nitrogen losses in the soil’, farmer Boersma stated during a study meeting in 1999.

The farmers also stated that a package of activities based on the systems perspective could lead to a quality of manure that causes less ammonia volatilization so that broadcast surface spreading could be reintroduced as a manure application technology. They considered that, following the systems perspective, a reduction of the amount of mineral N in manure through low-protein and high-fibre diets, together with broadcast surface spreading of manure, the use of additives and taking into account weather conditions, would be an adequate alternative to shallow injection.

Strategy 3: Experimenting with the use of additives

As mentioned earlier, the farmers were experimenting with additives, such as EM and Euromanure mixture, in order to improve the farming system. The strategy to use Euromanure mixture was based on the idea that it would result in a better quality of manure with less ammonia volatilization. The strategy to use EM was based on the fact that it would result in higher microbe content at farm level; resulting in healthier cows, better quality of the soil and an improved manure application. Euromanure mixture was supposed to lead to a better quality of manure which reflects the expectation of a one-to-one relationship. EM on the other hand, was expected to lead to a spectrum of effects.

The farmers used different types of evidence for their claims, which they eagerly explained during a meeting with the animal feed industry in September 1999. First of all, they could smell that the manure treated with EM was less sharp. Their assumption was that the smell of manure indicated the amount of ammonia volatilization. Secondly, they explained that when they applied manure that was treated with additives, they saw that the grassland did not get damaged. That is the second indication that the manure contains less ammonia. Thirdly, they expressed their observations that the thickness of the manure had improved and finally, they expressed that it was easier to spread it evenly on the grassland.

Farmer Hoeksma, who had used additives since 1981, explained that he gathered evidence of the effects of additives. He measured the Norg content of his soils and he concluded that after he started using the additive Euromanure mixture in 1981, the Norg content had increased. There were also other observations made by farmers, and which they expressed in study meetings, in which the additives played a significant role. For example, Eshuis *et al.* (2001:114) describe that the farmers had compared the number of worms in their grassland spread with EM with the number of worms in the grassland of the neighbours. They found more worms in their own grassland.

The guidelines for the use of additives in the Nutrient Management Project were the following: the farmers of the Euromanure mixture group would add 2 kg/m3 of the additive. This additive was supposed to be the most effective with broadcast surface spreading of manure. The farmers of the EM group sprayed the additive three times a year. The mixture of 1 litre of EM +1 litre of molasses +30 litres of water had to be ripened for a week and then added to 300 litres of water and sprayed on the land (Benedictus *et al*., 2001).

4.5. Knowledge activities to investigate the promising novelties

The aim of the Nutrient Management Project of VEL and VANLA was to develop knowledge activities based on the novelties formulated in the first stage of the process. In the course of time, two components started to form the basis of these knowledge activities. The first component was the interaction between scientists and dairy farmers in the research council and at the study meetings. They discussed their observations and analyses among each other and within their own communities. The second component was that the research activities – for a large part deliberately – were performed on location, namely in the fields and at the farms of the dairy farmers involved. The interaction between the different actors in the research council and at the study meetings was crucial. During the discussions within the research council, a shared understanding of the promisingnovelties to be investigated was developed. Study meetings were an important way to enhance the exchange of information. During these group meetings, the farmers' findings were discussed, compared and contrasted. A specific topic related to nutrient management was discussed, based on the experiences of the farmers (Eshuis and Stuiver, 2004).

The research activities developed during the Nutrient Management Project showed a pattern. At first, the main objectives of the project were to investigate the dietary composition of the feed and fodder and the grassland management practices. Methods of manure application and the use of additives were researched as well. Later on, new types of research were articulated; the analysis of soil processes, institutional design and analysing the systems perspective. This pattern was reflected in the network of researchers and departments that became involved in the research activities. Over the years, the number of researchers expanded from ten persons to more than twenty persons. During the first phase of the project, the team of researchers was composed of three different groups. The first group was composed of researchers of the research groups of Van Bruchem and Van der Ploeg that were actively promoting and implementing the three main promising novelties. The second group was composed of scientists that researched soil science and grassland management. These researchers wanted to develop new lines of research; for example, they studied the interactions between farm labour and physical soil characteristics, developing into different directions (Sonneveld and Bouma, 2003; Sonneveld *et al*., 2002). The third group was composed of researchers affiliated to the Animal Sciences group and researchers of Plant Research International that were involved as a prerequisite for the financing of the Nutrient Management Project. They were involved in grassland experiments and research into additives. During the second phase, other researchers started to participate in the project. These were researchers of the Department of Rural Sociology, the Department of Organic Agriculture, researchers of the Department of Soil Science and Soil Biology. In the following table, the different research practices are summarized:

Table 4.1. Research activities of the VEL and VANLA Nutrient Management Project (1998-2003)

Research activities 1998-2003	Additional research activities 2000-2003
Data base on nutrient management of 60 farms	Social analysis on institutional design
Experiments with additives	Monitoring farmers' learning processes
Experiments with soil conditions, grassland management and land use at 12 farms	Monitoring relationships between fodder and manure quality at 8 farms
Experimentation with manure practices, additives and grassland production on 2 on-farm plots	Measurements of nitrate levels
	On-farm experiments with ammonia emissions and manure quality
	Analysing the systems perspective
	Experiments on soil and soil life

Knowledge activities that focused on a lower fraction of Nmin in manure

In 1999, Reijs, a scientist from the Department of Animal Sciences of Wageningen University, started with a research based on the hypothesis of Van Bruchem that manure quality depends on the composition of the diet. He monitored twelve farms during three winter periods to obtain empirical information on diet composition, manure composition, herd performance and their interrelations. One of his objectives was to get insight into the potential of the proposed feeding strategy to adjust manure composition (Reijs *et al*., 2003).

Reijs followed the experiments with the composition of the diets at twelve farms during three winter periods. He took the stories of the farmers about the health of the cows and the quality of manure as a starting point. He collected a variety of data on the manure contents and the diets of the cows. He noted down the experiences of the farmers.[xxvii] In his research he used various indicators that were brought forward at the study meetings by the farmers and Van Bruchem to understand the processes.[xxviii] His research indicated that there was a relation between the composition of the animal diets and the composition of manure (Reijs *et al*., 2007) and that there was still a lot of research to be done on the details of this new feeding regime. The diets with changing values of protein, starch, sugar and fibres that the farmers had developed in the course of time in the Nutrient Management Project were worth investigating further (*ibid*).

Reijs' research was brought forward by Van der Ploeg as an illustration of the new role scientists could perform in co-developing sustainable novelties with farmers. Since his research took the stories of good manure that were told by the farmers as a starting point, he integrated these stories within the systems perspective he used; 'Reijs departs from the idea: It might be true that the farmers are right. Materiality has more ways to unfold. Not like most animal scientists who assume that materiality has only one linear way of unfolding.' His colleagues also considered Reijs' research activities to be an epistemological experiment with the aim to integrate farmers' knowledge and expertise in scientific research.

During his research, the farmers started to recognize themselves in his research findings. For example, during a meeting, Reijs presented his research findings. Bloemhof looked at the place he represented in the diagrams that Reijs showed. He showed me that with regard to the fertilizer use and nitrogen efficiency, he had the largest deviation from the average. He laughed about his own position in the diagram and commented on it: 'You can see that one farmer has adopted the way of working of VEL and VANLA in his own special way. Do you see that as well?'

Knowledge activities on manure application

The research council decided to investigate the assumption that ammonia volatilization is related to the amount of Nmin in the manure. The estimation was that manure quality could be indicated on the basis of the amount of Nmin. In other words: manure with a high quality (good manure) contains less Nmin and results in less volatilization. During a research council meeting the Nutrient Management Project decided to research the effects of this VEL and VANLA manure on ammonia volatilization. Scientists from the Department of Agro technology and Food Strategies of Wageningen University and Research Centre performed a field trial on ammonia emission in the VEL and VANLA area in 2003. The aim was to see the effects of a 'VEL and VANLA diet' (which means a protein-poor and fibre-high diet) on the reduction of Nmin in the manure (Huijsmans *et al*., 2004).

For the field trial, the scientists used two types of manure: manure from a VEL and VANLA farm and manure from a farm with protein-rich silage and protein-rich, low-fibre concentrates as by-products. The latter manure was chosen because the manure application laws of the government are based on manure of dairy farms that use the latter diet. The two types of manure were applied by broadcast surface spreading (Huijsmans *et al*., 2004). This field trial showed that ammonia volatilization is related to the amount of Nmin in the manure. The conclusion was that the strategy proved to be right: manure quality can be indicated on the basis of the amount of Nmin. The other conclusion of the research included the variable conditions in which the manure was applied on grassland. Research of Huijsmans *et al.* (2003) affirmed the estimations of the farmers that ammonia volatilization increases with dry, warm, sunny and windy weather.

Van der Stelt from the Department of Soil Chemistry and Chemical Soil Quality also did research for the environmental cooperatives to understand more about the relation between manure quality and ammonia volatilization. His conclusions were: ‘Considerable lower amounts of NH_3 were emitted from manures produced by non-lactating cows which were fed diets with a lower dietary protein content. Moreover, adjusting the diet will reduce NH_3 volatilization at any time of manure handling, e.g. during housing, storage, and during and after application of manure, which is not always the case for volatilization reduction techniques.’ (Van der Stelt, 2007: 135)

As mentioned earlier, the farmers considered the role of soil life, especially earthworms, as important for the optimal functioning of their soils. Since the allowed application of N to grassland has become more limited, farmers became more dependent on soil biological processes that influence soil-N-use-efficiency (Van Vliet *et al*., 2007). Different lines of research were set up that aimed to understand more about the relations between biological processes in the soil, Norg content, mineralization and manure application.[xxix]

Scientists of the Department of Soil Quality researched the effects of manure application technologies on the earthworm populations. They distinguished three kinds of earthworms in the soil. Earthworms that belong to the first and second category live deeper than twenty cm in the soil. These earthworms benefit from shallow injection since injection puts manure deeper in the soil and they can reach it better. However earthworms that belong to the third category, i.e. the earthworms in the topsoil, are most important for soil processes because of their quantity. These worms get killed through shallow injection. These worms are also exposed to a high salt content in the topsoil during shallow injection, which is damaging the soil. More earthworms are found in soils where manure is applied through broadcast surface spreading (Goede *et al*., 2003). Accompanying research, in which de Goede participated, focused on the contribution of the earthworm populations to the nitrogen dynamics in the soil (Postma-Blaauw *et al*., 2006). This research indicated that the effects of earthworms on nitrogen mineralization depend on the ecological traits of the earthworm species present, and can be modified by species interactions (*ibid*). So, the conclusion of the research of de Goede *et al.* (2003) was that earthworms seemed to play an important role in the nitrogen cycle in the soil. Through their activities, they influence the mineralization of Norg directly and indirectly.

Scientists of the Department of Soil Quality also investigated the relation between a mineralization rate and the number of earthworms in grasslands with various Norg content (Van Vliet *et al*., 2007). To do this research at nine farms of the Nutrient Management Project, two grasslands that had a different Norg content were selected. The research claimed that for every farm, the grassland with the highest Norg content contained the largest populations of earthworms and had the highest number of cocoons (*ibid*). These grasslands also had the highest root biomass. With an increase in Norg in the soil, the potential nitrogen mineralization increased (*ibid*).

Knowledge activities on additives

From 1999 until 2003, a field trial was conducted at two farms. The field trial examined the effects of manure application, manure quality and additives on grassland production, Norg content and the botanical quality of the grassland. The farms that were chosen were the farms of Hoeksma, who was part of the Euromanure mixture group and Sikkema, one of the farmers of the control group. The trial was designed as a traditional manure application trial. This was done for statistical analysis purposes. Soil biological processes were also measured. Vellinga, a researcher of the Animal Sciences group was responsible for the field trial until 2000. From 2000, Schils of the Animal Sciences group was responsible. The field trial at the farms of Hoeksma and Sikkema resulted in two publications. The results of this research claimed that the additives did not give a significant result (Schils and Kok, 2003; Schils *et al*., 2004).

In addition to this, the Department of Soil Quality of Wageningen University performed a research into the additives in relation to ammonia emission. Different additives were researched: Euromanure mixture, Agrimest, EM and a combination of Agrimest with EM. They conducted an incubation experiment (Van der Stelt, 2007: 133). Van der Stelt concluded that the use of additives did not change manure characteristics and did not result in a decrease in NH3 emissions. Addition of EM had no measurable effects on the bacterial diversity and the chemical composition of the manure. In a pot experiment, no effects of EM on nitrogen uptake[xxx] and grass biomass production were recorded either (Van Vliet *et al*., 2006). The research indicated that only at 4 degrees Celsius and with no mixing of the manure, a decrease in NH3 volatilization was observed, when a combination of the additives Agri-mest and EM was applied to manure (*ibid*).

4.6. Conflict and alignment within the Nutrient Management Project of VEL and VANLA

The different actors exchanged knowledge developed during their research activities at the research council meetings and study meetings. Furthermore, they exchanged their arguments and opinions about the question 'what is valid knowledge'. In the following section the processes of conflict and alignment that took place in the Nutrient Management Project of VEL and VANLA are described.

The validity of systems thinking

In 2001, a dispute took place following the publication of the book 'Good manure does not smell' (in Dutch: *Goede mest stinkt niet*) (Eshuis *et al*., 2001), between the authors of the book and scientist Schröder, researcher of Plant Research International (PRI). Schröder criticized the scientific validity of the claims made in the publication.

In the book the soil-plant-animal system is investigated. It explores the management options it entails. Farmers' experiences with making manure are brought forward as valuable novelties. Several statements are made in the book in favour of broadcast surface spreading. For example, the book argues that using heavy machines like the shallow injection machines causes destruction of the soil structure. A plea is made in favour of using high-fibre and low-protein diets. It is presented as a valuable option for the farmers to optimize nitrogen efficiency and reduce the nitrogen losses. The systems perspective is also presented in this book as a viable alternative for developing knowledge about manure practices in the Netherlands.

Schröder did not agree with the claims made in the book. Some claims were proven by scientific facts, he argued, like the fact that shallow injection is bad for soil life. Other claims made in the book were not proven in his opinion. First of all, he did not agree that the measures applied by the farmers within the Nutrient Management Project of VEL and VANLA were sufficient to allow surface broadcast spreading of manure. In his opinion, this claim was insufficiently defined and not underpinned by evidence of causal relationships or statistical data. For example, he questioned the use of C/N and whether this indicator can be influenced by the dietary adjustments proposed by Van Bruchem. He agreed with Van Bruchem that the dietary adjustments decreased Ntotal or Nmin in the manure. However, the claim that Norg also would increase through the dietary adjustments and the use of additives, as undertaken by the farmers, was to be contested in his opinion. First and foremost, the use of straw would increase Norg and not the other measures proposed. And the most important argument of the farmers, namely that the changes in Nmin and Ntotal in the manure would be large enough to allow broadcast surface spreading of manure was not proven at all, in his opinion. Secondly, he agreed that the systems perspective indeed can serve as a tool to show the nitrogen flows in the farming system. Nevertheless, the specific claim of the farmers and Van Bruchem that a combination of changes in feed, manure and soil would result in a system innovation was, in the opinion of Schröder, not more than a hunch, or a hypothesis, and not a sufficiently validated theory. Thirdly, he argued that not only the Nutrient Management Project of VEL and VANLA could claim these findings. Other nutrient management projects in the Netherlands (see chapter 3) worked with their own variations of the systems perspective. For instance, *de Marke*, Centre for Dairy Farming and Environment and closely connected with the animal sciences group of Wageningen University, also introduced the systems perspective as a means to overcome the crisis in the manure regime at the end of the eighties (see Aarts *et al*., 1988; Korevaar *et al*., 1988). Finally, he stated that the scientific quest would be to discover the crucial factors within the system that are responsible for the changes in N efficiency. In his opinion, looking at a lot of factors (like the diets, additives and straw) at the same time, as it occurred within the Nutrient Management Project of VEL and VANLA, did not help the farmers, but only made the scientific analysis blurred, since there could also be factors included in the systems perspective that were not relevant at all. He thought it was the task of the Nutrient Management Project of VEL and VANLA to avoid that the farmers would get burdened with measures that were not effective.

Another situation at which different arguments about the systems perspective popped up was during a meeting of the research council in 2003. The scientists Schils, Schröder, Van Vliet, and the farmers Feenstra, Nijboer and Bloemhof participated in a discussion about the relation between science and practice in the Nutrient Management Project. The discussion started with the question from scientist Van Vliet what the farmers considered to be the value of the systems perspective. Farmer Feenstra responded to this question with the statement that it was a mental change. As an example, he proposed to look at the use of additives. He stated: 'Although scientific research until now has not given us any evidence, for us as farmers scientific evidence is not the most important thing. The mental change is important: a change to more sustainable farming and that is where the systems perspective including the use of additives is useful for.' Schils responded by asking for more measurable criteria to show that the system perspective of Van Bruchem really worked. Feenstra answered that for him it started with using less fertilizer and then with changing the feeding strategy. Nijboer added to this that the main topic was to make more use of one's own manure. Bloemhof agreed with Nijboer and stated that the manure quality was important; and that it was important to strive towards a C/N of 10. In other words, the farmers responded by highlighting different adjustments in their management decisions based on the systems perspective. Schils repeated his question about the measurable indicator. 'What', he said, 'would have happened if Hoeksma only had used less fertilizer. Would there be a difference with what he has achieved now?' Nijboer stated in response that in his opinion, you cannot reduce it to one factor and that 'you have to think in systems.'

In the conflict described above it becomes clear that the participants had different opinions about the use and value of the systems perspective as developed within the Nutrient Management Project of VEL and VANLA. The farmers argued that the systems perspective was a workable tool for the management of their farms even if it was not scientifically proven that all measures worked.
The scientists in the Nutrient Management Project were divided into two groups with two different opinions. The first group of Eshuis *et al.* (2001) embraced the standpoint of the farmers and considered it to be relevant options to develop more insights into the systems approach as such. Another group, including Schröder did not deny the significance of the systems perspective as a hypothesis but still wanted to gain more insights into the crucial factors that resulted in changes in the farming system.

The grassland experiment revisited

The second conflict that arose among the participants of the Nutrient Management Project dealt with the grassland experiment conducted at two different farms. The conflict was between Van der Ploeg on the one hand and Schils and Kok on the other hand. From the beginning, they had different ideas about the goals and aims of the grassland experiment which resulted in two different interpretations of the results of the grassland experiment (see Van der Ploeg *et al.*, 2006; Schils and Kok, 2003).

The grassland experiment was designed in the following way. Two types of manure were chosen, the first being Hoeksma's manure based on a protein-poor and fibre-rich diet and treated with additives. Another farmer was chosen, Sikkema, who was considered to represent the old regime as he used a protein-rich diet with low fibre, which resulted in a different type of animal manure on his farm. Furthermore the grassland experiment was performed on two different types of land; one was supposed to be 'improved' land (in terms of Norg content), the other one was supposed to be conventional land. Technically, the experiment was reduced to a randomized complete block with two replicates on each farm: two types of manure, two methods of application, two levels of additive use (none, EM plus 2 controls), two nitrogen fertilization levels, two replicates per farm, two farms, resulting in 80 experimental plots (Van der Ploeg *et al*., 2006: 2003).

Schils and Kok performed research on the plots of Hoeksma and Sikkema. They wanted to measure the effects of application method, cattle slurry manure type and use of additives on (1) nitrogen (N) utilization, (2) soil Norg and soil N content, and (3) botanical composition of the sward (Schils and Kok, 2003: 41). They analysed the data by means of programmes for analysis of variance and multiple regression analysis (*ibid*). They concluded from this research that manure type and additive use had no consistent effects on grass yield or N utilization. Moreover, the application method had no effect on the measured soil characteristics. Application method, slurry manure type or additive use did not influence the botanical composition of the sward (Schils and Kok, 2003). One other conclusion was that shallow injection showed less volatilization, irrespective of the fact whether it was Hoeksma's or Sikkema's manure; in other words, whether is was treated or untreated manure. In their words: 'N utilization of slurry manure was 18 per cent higher with shallow injection as compared to broadcast surface application' (Schils and Kok, 2003: 63).

A heated debate arose in the research council in which Van der Ploeg strongly opposed these conclusions. Van der Ploeg wrote an article in which he criticized the methodologies of Schils and Kok and described them as 'institutionalized research routines (Van der Ploeg *et al*., 2006: 213). Van der Ploeg criticized the scientists to represent these routines, because they asked standardized research questions and used standardized methods (Noorduyn 2003b). Van der Ploeg argued that you cannot sum up all the plots where broadcast surface spreading took place and compare these with the total sum of the plots where shallow injection took place (*ibid*). In fact, in his opinion there were only two plots one could compare, the plot where Sikkema's untreated manure was combined with his type of land and method of application and the plot where Hoeksma's treated manure was combined with his type of land and method of application. Furthermore he stated that 'their analysis excluded the possibility of identifying the potential relevance of the difference between N-rich and N-poor manure as the required corrections following the unintended dilution of manure, were not made. Secondly, the potential effects of different soil qualities were not taken into account, which meant that little or no attention was paid to potential interaction effects' (Van der Ploeg *et al*., 2006: 213).

Van der Ploeg also interpreted the results of the grassland experiment (Van der Ploeg *et al*., 2007). His statistical methods were based on multivariate analysis in which he focused on the interrelations between the different measures; 'the phenomenon of statistical interaction needs to be taken into account. This phenomenon implies that the causal effect that one variable has on another one may be moderated or even hidden through the influence of a third (, fourth or fifth) variable. That is: a causal effect may exist in one condition, whereas it does not emerge in another' (Van der Ploeg *et al*., 2006: 206). Van der Ploeg calculated that the influence of Hoeksma's manure together with improved land and broadcast surface spreading did give promising results; 'improved manure raises the efficiency of grassland production—especially when improved manure is combined with other novelties, such as improved land, improved application and adapted fertilizer quantities. More generally speaking, the potential value of re-balancing (as a comprehensive strategy to reduce N surpluses) is demonstrated empirically' (Van der Ploeg *et al*., 2006: 213).

Van der Ploeg´s analysis was criticized by Schils and Kok as being validated by wrong statistical procedures and 'selective shopping' (Noorduyn, 2003b). Schils and Kok also argued that you cannot make conclusions on the basis of two farmers; therefore you would need more than only two farmers to compare. Van der Ploeg accused Schils and Kok of disguising the significant statistical differences through their methods (see Van der Ploeg *et al*., 2006; Schils and Kok, 2003; Noorduyn 2003b). He argued that the institutionalized research routines that Schils had used were unable to represent, understand and support novel and promising practices correctly.

The conflict was taken up in the research council where it was decided that more research was needed to understand the relation between manure quality and manure application methods. From that time onwards, Huijsmans *et al* (2004) performed research that dealt with this question, as mentioned in the preceding section. The specific aim of this research was formulated in the research council, namely to discover the effects of what the farmers started to call a 'VEL and VANLA diet' (which means a protein-poor and fibre-high diet) on the reduction of Nmin in the manure (Huijsmans *et al*., 2004).

The effects of additives

The third conflict concerned the effects of the additives. The researchers that were sceptical about the use of additives referred to other scientific research (e.g. Kant *et al*., 1998). The farmers were sceptical about the findings of this experiment. They argued that the experiments had not been done in the context of a working farm and that the 'control' (untreated) manure that was used had a far lower N content than the manure they were used to work with.

The farmers considered additives very relevant for the development of their farms, although science could not prove that it is true. Boersma explained; 'We cannot really prove that what we are doing is right. Many people think it only costs money. I can only say that there are changes that I see, which perhaps cannot be put into official statistics, but they are relevant to me. We can however measure some of the outcomes; the farmers of the Nutrient Management Project who use Euromanure mixture have a higher C/N ratio in the manure'. He argued that official science cannot prove that it is true, but that he was convinced that additives have an effect on his farming system. He was certain that the indicator C/N showed that farmers who work with additives do well within the Nutrient Management Project.

In the beginning of the Nutrient Management Project of VEL and VANLA, the assumed effect of additives was a promising and interesting hypothesis, primarily based on the experiences of the farmers. Different research activities were performed (Van der Stelt, 2007; Van Vliet *et al*., 2006) within the Nutrient Management Project. However, on the basis of the findings of these research activities, no evidence was found that the effects of additives could be scientifically validated. The research done by Schils and Kok also analysed the effects of manure treated with Euromanure mixture. They concluded that there was no difference in emissions between treated and non-treated manure (Schils and Kok, 2003; Schils *et al*., 2004).

During the second phase of the Nutrient Management Project, the story that the farmers told about additives did not become a story shared by the research council, but it became an invisible component of the farming systems approach. For instance, in the course of the project, the research group that used additives became less visible in the results as a separate category. In 2000, when the first results were presented, the farmers were presented as three research groups, as we can see in the following quote; 'Between the three groups of the project, there are quality differences in the manure. The C/N ratio of the Euromanure mixture group is the highest (7.2), followed by the EM group (6.8). The control group has the lowest C/N ratio (6.4)' (Atsma *et al*., 2000: 28).

Reijs *et al.* (2004) also mentioned the three research groups in their findings. They compared (see figure 4.2.) the N surplus of the VEL and VANLA farms with the results of the Farmers' Data project (Doornewaard *et al*., 2002) and a reference group of dairy farms in Friesland (Anonymous, 2003f). With the presentation of this diagram they argued that all the three research groups of VEL and VANLA were successful in their collective efforts to reduce N surpluses. The average N surplus decreased from 299 kg ha^{-1} in 1997/1998 to 156 kg ha^{-1} in 2002/2003. They also described that by 2002/2003, 77% of the VEL and VANLA farms met the thresholds set by legislation for 2003 (the following growing season). They compared this figure with the 56% of the farmers from the Farmers' Data project that achieved this goal (Reijs *et al*., 2004).

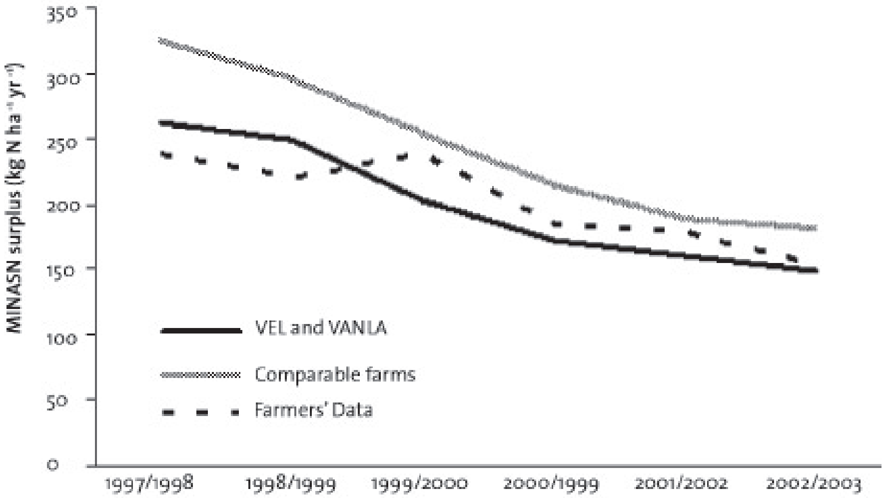


Figure 4.2. Progress of MINAS N surplus of the VEL and VANLA farms in comparison with the Farmers' Data project (Doornewaard et al., 2002) and a reference group of local farms (Anonymous, 2003) (after Reijs et al., 2004).

However, in the second phase of the Nutrient Management Project it was explicitly stated that the project would not focus too much attention on researching the effects of additives; 'After extensive negotiations with the participants and an internal evaluation, we decided that this 'support mechanism' remains part of the Nutrient Management Project, but in the background. Whether the additives really play a role in the reduction of the Nitrogen surpluses is researched at a distance' (Verhoeven, 2001).

The three conflicts illustrate that time and again, debate arose within the Nutrient Management Project about the validity of different scientific methods and hypotheses. This debate led to the eventual emergence of two groups of actors with differing ideas about the utility and relevance of scientific and farmers' knowledge.

The first group of actors that emerged advocated an approach to manure and fertilizer application on the basis of what came to be known as the systems perspective. The systems perspective is a way of organizing the dairy farming system. By managing the farming system as a whole and fine-tuning its subsystems, the nutrient efficiency in the system can be increased. Important features include the reduction of external resources coupled with the optimal usage of internal resources. The aim is to increase the quality of manure, so as to improve the fertilization of the soil. This enhances soil life and it increases the efficiency of nitrogen uptake and the quality of the grass. When cows graze on this high quality grass, the quality of their manure improves.

The systems perspective was grounded on the experiences of some farmers within the project, who realized a high nutrient efficiency. It was supported by scientists from Wageningen University and Research Centre (see Van Bruchem *et al*., 1999a; Van Bruchem *et al*., 1999b; Lantinga and Van Bruchem, 1999; Verhoeven *et al*., 1998). The group was convinced that the guidelines set by the government concerning nutrient management were based on averages from different test plots and repetitions. They argued that the research performed was derived from de-localized data and would not be suitable for realizing ambitious, environmental goals. They argued that the scientific models that were supposed to be universal within the agricultural sciences were far from universal and only valid in situations in which high amounts of artificial fertilizer were being applied, the manure and the soil had specific qualities and the grass species were modern varieties of Ryegrass. In short, the models were said to reflect the conditions on research plots, rather than local conditions at the project and at 'real-life' farms. What they considered to be a challenge for the agricultural sciences was to investigate the departures from the rule. Van der Ploeg and Van Bruchem were promoters of executing research that would develop and understand these novelties (Van der Ploeg *et al*., 2007).

The second group was composed of a team of scientists who criticized the specific use of the systems perspective as performed by the first group. They claimed that there was no proof based on the systems perspective to support the argument that it would be better to apply manure by traditional methods than using modern methods of shallow injection. Furthermore, they asserted that the additives did not make any difference to the quality of the manure, nor had any effects on the environment. In their opinion, the research that was performed by Van der Ploeg and Van Bruchem did not provide enough evidence that the systems perspective would create a radical new set of novelties that could alter the regime. The scientists in this group challenged the validity of other (sources of) knowledge like the experiences of farmers with manure application technologies.

In the three conflicts, two different stories can be distinguished that were based upon different lines of argumentation: one on 'scientific proof' and the other on the 'experiences of farmers'. The proponents of the systems perspective embraced the story that farmers' knowledge mattered, based on a pragmatic view of knowledge production. They pointed out that a number of farmers who did not work according to the prevailing scientific guidelines achieved excellent innovative results. They stated that the experiential knowledge of the farmers mattered in actual practice, even though it was not yet scientifically known how it actually worked. This turned out to be an effective story. It implied that scientific knowledge was 'lagging behind,' and incapable of understanding farming in practice. Scientific knowledge was also implicitly depicted as knowledge of 'average quality', because it led to sub-optimal results. The proponents of farmers' knowledge criticized the second group for not producing valid knowledge for the Nutrient Management Project. By contrast, they portrayed farmers' knowledge as 'practical knowledge' and 'workable knowledge' (Eshuis and Stuiver, 2004).

When the two contrasting stories were constructed, the distinction between the two emerging social groups became more evident because the actors involved in the Nutrient Management Project became attached to one of the stories: they were 'labelled'. Sometimes, actors formed an 'us-group' and a 'them-group' which increased separation and alienation between individuals belonging to different groups. People not yet belonging to a group were sometimes labelled as a member of one of the groups on the basis of the arguments they used. For example, in the discussion on the grassland experiment between Van der Ploeg and Schils, farm leader Atsma stated that he had the feeling that some of the scientists were not supporting the farmers' hypotheses but were defending the manure regime. Also, the scientists using farmers' experiences as a source of knowledge often positioned themselves as spokesmen and allies of the farmers towards government officials or other scientists in the academia.

4.7. The consolidation of storylines within the Nutrient Management Project of VEL and VANLA

Within the Nutrient Management Project, the following storyline had taken shape and was supported by the research done; it is possible to increase nitrogen efficiency by focusing on the quality of manure. The quality of dairy cow manure depends on the composition of N. N contained in dairy cow manure consists of Nmin and Norg. Nmin is directly available to plants whereas Norg has to be mineralized by soil microbes before it is available for the plant. The composition of N contained in dairy cow slurry can be influenced by the composition of the diet. Efficient protein feeding reduces the amount of Nmin (Külling *et al*., 2001). In general, slurries with a relatively low Nmin content have a lower N availability compared to slurries with a relatively high Nm content (Reijs *et al*., 2007). On the other hand, Nmin is susceptible to loss through volatilization and this volatilization directly decreases N availability (Huijsmans, 2003). The volatilization of Nmin is highly variable as it is influenced by weather and soil conditions. Furthermore, the effects of shallow injection on the soil have to be taken into account. Shallow injection has a negative effect on soil life and the worm populations in the top soil, compared to broadcast surface spreading. Since worm populations are important for soil life and the processes of mineralization of Norg (Goede *et al*., 2003), it can be argued that shallow injection of manure is bad for the soil. Good manure needs other treatment than bad manure; other quantities that are applied, other times of application, other weather conditions and other ways of application.

The above-mentioned storyline can be summarized as the storyline of making good manure. It is a management storyline in order to reduce N surpluses at the dairy farms: 'Making good manure is a good way to achieve the standards set by the government. It means that we try to influence the quality of manure by reducing the amount of Nmin in the manure. We make this good manure by altering the feeding strategy. Using the silage of our own farm becomes more important. The cows are fed with limited amounts of concentrates. Instead we use silage from our own farm with a higher fibre and lower protein content. The advantage of these diets is that the indicator C/N increases in the manure. This reduces ammonia volatilization and nitrate leaching and it contributes to Norg in the soil.'

During the Nutrient Management Project, a carrying network emerged that combined several stories on nutrient management, and in this way sculptured the storyline of good manure as a viable management option for farmers. The storyline of making good manure was reflected in the research activities of different groups of scientists. The stories of Hoeksma on Norg, the stories of Van Bruchem about the relation between diets and manure quality, the acceptance of farmers' knowledge as workable knowledge that can provide novelties, the research on soil life (Goede *et al*., 2003), manure (Reijs *et al*., 2004) and the grassland experiment (Van der Ploeg *et al*., 2007) as well as the research on the relation between Nmin and ammonia volatilization (Huijsmans *et al*., 2004) contributed to the storyline. During these research activities, new entities were discovered e.g. the contents of the soil, soil life and biological processes in the soil, a rehabilitation of specific methods of manure application and the use of additives. New indicators appeared, like the RC, RE and the C/N ratio. These new entities all played a role in the narration and embodiment of the storyline of good manure. The additives disappeared as entities, as became gradually clear that they were not strong allies in making the claim come true. As we have seen in the preceding section, the storyline of good manure was moulded in the processes of conflict and alignment as these took place within the research council and study meetings.

The storyline of good manure was rationalized in terms of the total system. The plot of the storyline is the following: 'Good manure is manure that is good for the total farming system. It is manure that is good for the grassland, that produces good grass (with more fibre and less protein), that is good for the cows, who produce better manure. When 'we' make this good manure our farms will flourish and survive.' The farmers positioned themselves in the storyline as important agents. If they followed this management story, their farms would develop according to sustainability goals.

The system perspective was the second storyline that was formed in the exchange between the participants of the project. The systems perspective has been phrased in different ways; first it was called the 'Van Bruchem method'. The members of the project later on referred to the systems perspective as the 'VEL and VANLA' method. The systems perspective legitimized the joint activities to make good manure. The systems perspective linked the different novelties, practices, regulations and technologies within the project.

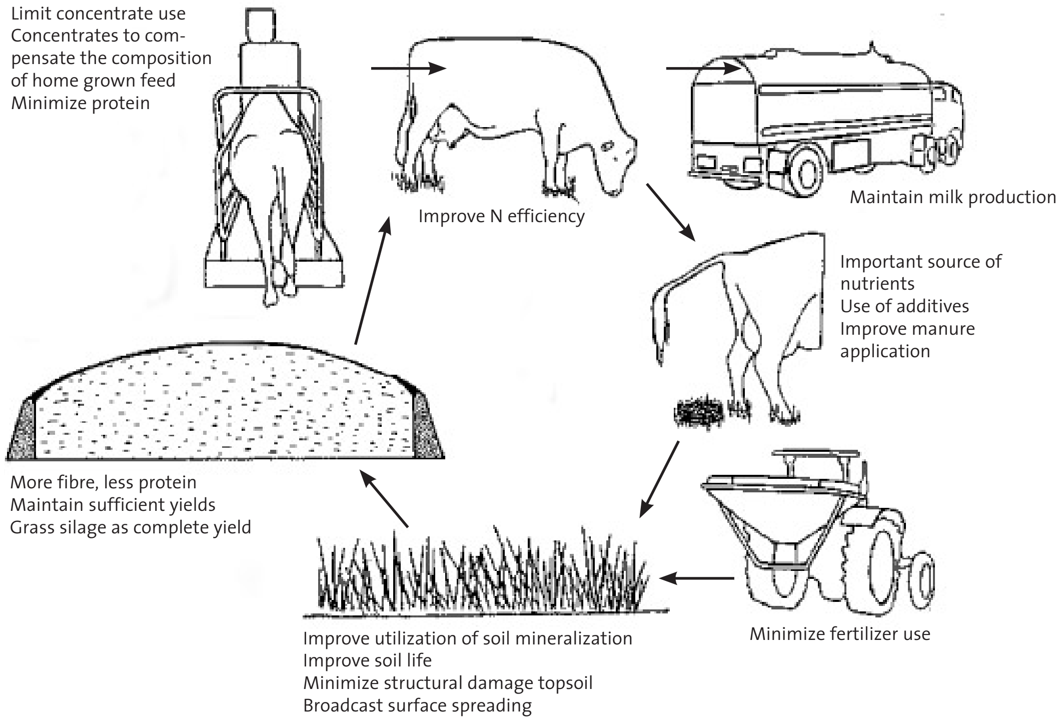


Figure 4.3. The measures the farmers performed, depicted in the systems perspective

Figure 4.3. is the specific version of the systems perspective as it developed within the Nutrient Management Project of VEL and VANLA. Variations of the systems perspective were also present in the research design of the APM (Hylkema, 1999) and *Koeien en Kansen* (Aarts *et al*., 1988). Within the Nutrient Management Project of VEL and VANLA, the version proclaimed by Van Bruchem was aligned with the novelties of the farmers who optimized the systems perspective in their own practices. The systems perspective became the challenge of all the participating farmers to optimize their nitrogen efficiency. Farmers and scientists created an understanding of the background of the data and their interrelations. They came to understand the nutrient flows at the farm, and how the farmer managed these flows. The farmers provided hypotheses to understand the system perspective and collected data of their farms, which scientists used to parameterize and calculate the soil-plant-animal system of each farm (Groot *et al*., 2003).

In the course of time, the systems perspective and accompanying measures for making good manure were brought forward, in the publications and presentations to the farming communities (see Noorduyn 2003a; Verhoeven *et al*., 2003a; Verhoeven *et al*., 2003b; Verhoeven *et al*., 2002).

The project leaders were active narrators of the systems perspective. They disseminated the systems perspective to the outside world and made use of the research in the Nutrient Management Project of VEL and VANLA that supported their claims.

In the debates that arose within the Nutrient Management Project, the systems perspective was used as a storyline about science. It became part of experimenting with a different epistemological view on science. The narrators of the systems perspective aimed to change the academia's look on the question 'what is true knowledge.' First of all, the narrators of the systems perspective considered the interdependence between different aspects of farming to be an important part of the analysis. Secondly, with the systems perspective, they integrated farmers' knowledge and novelties (Van der Ploeg *et al*., 2007) as a crucial element of scientific enquiry.

The narrators of the systems perspective believed that the scientific community could learn from the systems perspective developed in the VEL and VANLA project. They compared their activities with the activities of other nutrient management projects in the Netherlands. Their opinion was that in the project of Koeien en Kansen, the scientists still worked in a reductionist way. The farmers stated that it was important that, what they considered to be the 'vested knowledge infrastructure', would adopt their storylines. This is shown by the following quote of farmer Atsma; 'It is up to the scientists that work with us to translate our ways of farming into science and politics. We, as farmers, are convinced it works, because we see evidence in the results of the farm. Now scientists translate it into scientific results, but not in a reductionistic way as scientists are often used to. '

The preceding quote shows that Atsma was convinced that scientists needed to find ways to develop new epistemologies to understand the novelties of the farmers. It illustrates the image of the regime that often was brought forward during the research council and at the study meetings. The farmers and some of the scientists created an image of the existing manure regime and its accompanying knowledge infrastructure that needed to integrate the storyline of good manure as well as doing research from the systems perspective (see Van der Ploeg *et al*., 2007).

Some participants were brought forward as examples of innovators that contested this regime. For instance, Hoeksma was often brought forward as an innovator because Hoeksma made choices that did not fit in with the trends of the time (Koen, 2001). Very often, he gave speeches to extension workers and scientists on the knowledge he developed on his farm. Hoeksma collected his own farm data, interpreted the data and told about them to others. He was taken as an example in view of the novelties discovered in the Nutrient Management Project (see Van der Ploeg, 2003) and his manure was chosen as the 'improved' manure during the grassland experiment (see Van der Ploeg *et al*., 2007; Schils and Kok, 2003). Hoeksma was often brought forward as a farmer who questioned expertise of scientists and focused on his own knowledge production. Van Bruchem was also considered to be an innovator by the farmers in proclaiming the systems perspective.

During the interactions in the research council the farmers often divided the scientists in two groups: those in favour of the novelties and those in favour of the dominant regime. In the discussions, the farmers often referred to some of the researchers of the Institute of Animal Husbandry and Plant Research International as representatives of the old models of science and the vested interests in The Hague. The farmers considered the negotiation processes (e.g. about additives) within the Nutrient Management Project of VEL and VANLA part of the struggle to change the regime. The farmers stated that in the course of time they became critical about scientists and extension workers that participated in the project, as shown by the following quote of Atsma: 'There is so much to learn from colleagues. To see with your own eyes what goes right and what goes wrong'. In this way, one gets trust in what one does for himself. Before that, we trusted scientists and extension workers. Now we are much more critical about them'. One other example, in which the struggle against the regime was often visible, was the discussion about broadcast surface spreading of manure during the research council meetings (see chapter 6). When scientists stated that they considered the law on application of manure to be valid, the farmers of the Euromanure mixture group responded by stating that they did not disagree and that they needed the scientists to give validations for the arguments of the farmers instead of defending the regime.

During these interactions, a third storyline emerged among the narrators of the systems perspective, based on a different plot. The Frisian farmers and the scientists presented an image of The Hague as being a Goliath who had to be defeated. The farmers of VEL and VANLA described themselves as opponents of a government that continues to threaten their natural environment, the hedges and belts of elder trees their farms were situated in and which they were active guardians of.'

Goliath became synonymous with the dominant manure regime that forced the farmers to increase scale and destroy their small-scale parcels and landscape. Goliath needed to be defeated by David (read VEL and VANLA) who started to use different weapons, clothes and tactics that fitted him better. David might be small but could conquer the giant when he became 'smart' enough. The aim was to overthrow Goliath and search for the weak spot.

The David vs. Goliath plot expanded the development of science beyond the closed boundaries of scientific laboratories. It took novel ideas of farmers as objects of research. Heterogeneous modes of knowledge production became relevant. Expertise was a different matter now. The Davids considered more ways of knowing and truth- finding as valuable, in addition to those that were dominant within science. Examples are stories, farmer's experiences with farm management in their specific region and localities and systems thinking. Van der Ploeg was an important narrator and actor in the David vs. Goliath plot within the political and scientific community. He stated that within modernization, non-institutional forms of expertise are made invisible (see also Wynne, 1996). Van der Ploeg described it as follows, when the Standing Committee of the Ministry of LNV visited the Nutrient Management Project in 2000: 'VEL and VANLA work as niches, strategic field laboratories. The nutrient balances were the start; they want to make good manure and apply it in a good way and develop knowledge about it. They want to maintain their own landscape and experiment with adapting their farming systems in their own localities. That is a good reason for the academia and the government to invest money not only in traditional laboratories, but also in field laboratories. And it is important to see where they meet with problems, for instance with manure application methods, and also with the norms from Brussels that only count the number of cows, but do not look at the quality of manure produced by the cows.'

Although the farmers were convinced that their ideas were true, their image of the giant was in such a way, that they believed it was difficult to conquer him. Atsma said, in an evaluation of the Nutrient Management Project: 'Sometimes I think, Wageningen why don't you take the chance. But then I see who are working there, and who are working at the Ministry of LNV. I can imagine that if you have invented manure application technologies, you cannot just say that it these have been wrong for ten years. I can imagine that.'

4.8. Conclusions

This chapter describes 60 farmers and 30 scientists who cooperated within the scope of the Nutrient Management Project of VEL and VANLA in Friesland, in the North of the Netherlands, between 1999 and 2004.

The Nutrient Management Project was initiated by a small group of scientists from Wageningen University and Research Centre and farmers from the VEL and VANLA cooperatives that recognized each other in their criticism on the dominant manure regime in Dutch dairy farming. They also had the same conviction that they experimented with novel ways of making manure to be found at the farms of some of the farmers within the environmental cooperatives. In their opinion, existing nutrient management projects were not radical enough to realize the necessary regime change to sustainability. They looked for cooperation with a wider group of farmers within the VEL and VANLA cooperatives. They aimed to find new ways to manage their manure practices, to discover new trajectories of knowledge development within the agricultural sciences and to discover new ways to institutionalize and govern manure practices within the Netherlands, eventually leading to a new regime.

The group of farmers and scientists formulated different novelties to discover new knowledge about manure practices, like decreasing fertilizer use, improving manure quality, adapting the techniques for the application of manure and using additives. The Nutrient Management Project also aimed to open some of the 'black boxes' of agricultural sciences and tried to identify new ways of looking at the relevance of resources like manure, grass silage and soil. New indicators that serve as a bridge between science and the newly developed practices were also experimented with. One example is the C/N ratio of manure, as an indication of the quality of manure.

During the Nutrient Management Project, two views on 'what is valid knowledge' developed among the participants, during processes of conflict and alignment. The first group of actors argued that knowledge development should be based on the analyses and experiments of neutral (or objective) scientists that produce theories on the basis of the analyses and measurements of facts. The second group embraced an epistemology in which farmers' knowledge and new interpretation schemes like the system perspective were considered to be valid sources of knowledge. The latter view on knowledge became the dominant perspective in the debates and publications of the Nutrient Management Project and resulted in three emerging storylines on manure.

The storyline of good manure developed during the experiments of the Nutrient Management Project. Normative views about what is 'good' and what is 'bad' manure became more manifest. What they called good manure is manure that produces less ammonia, which was indicated by the percentage of Nmin in the manure. The systems perspective of the Nutrient Management Project became a shared storyline among a group of the participants. This farming systems approach was articulated to change dominant epistemologies within scientific research. A network of actors within the Nutrient Management Project embraced these two storylines. The research practices and controversies, for example about additives, showed that a lot of networking needed to take place in order to make the storylines robust.

An important way to create alignment among the narrators of the storylines was to incorporate the two storylines in a David vs. Goliath plot. David was the symbolic form of the niche the farmers and scientists attempted to create in order to overcome Goliath, who stands for the modern manure regime and its knowledge infrastructure. With the David vs. Goliath plot the narrators of the storylines were aligned in changing the manure regime in a radical way. They aimed for a transition of the manure regime towards a regime that supported making good manure, in its policies and knowledge infrastructure. The David vs. Goliath plot legitimized their actions. It was a layman's storyline about Strategic Niche Management. This design option is equivalent to the rural development paradigm (Van der Ploeg and Roep, 2003); it aims to develop regional diversification of farming systems and rural policies, through novelty creation in different directions, resulting in and celebrating diversity in the regime.

An image of the 'outside world' was created to reach alignment among the members. This image implied that science and government policies did not give the farmers enough room for the alternatives to the ingrained configurations from the past. Stories, experiences and systems thinking were the starting points to fight against this dominant regime. The actors came to terms in their need to develop strong evidence about the robustness of their alternative trajectory to convince the scientific and policy community.

The farmers and scientists gained a central role in the storylines through the David vs. Goliath plot. They considered themselves to be part of this struggle. In other words, their activities and their cooperation within the Nutrient Management Project got significance by a storyline of regime change, in which they considered themselves to play a vital role.

People

source unknown

Scientist Sonneveld conducting field experiments at grassland of farmer Bloemhof

source unknown

Farmer Boersma in front of silage storage

photo M. Stuiver

Farmers of Vel and Vanla visit research centre Ny Bosma Zathe in Friesland

photo J. Groot

Farmer Hoeksma gives a presentation at a research council meeting of Vel and Vanla

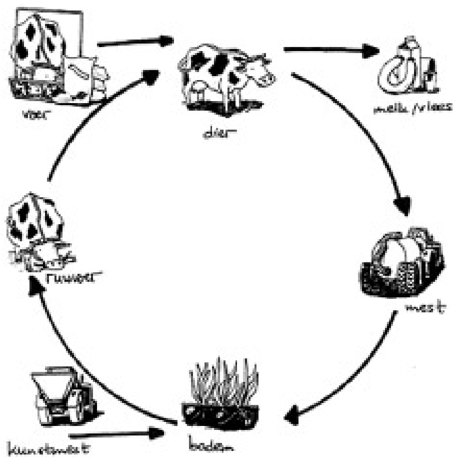
Soil-plant-animal system

source Bedreven bedrijven Drenthe

The diagram of Vel and Vanla used in publication of nutrient management project Bedreven Bedrijven in Drenthe (the Netherlands)

source PMOV

The diagram of Vel and Vanla used in publication of PMOV



source Praktijkcijfers

The diagram of the soil-plant-animal system of Praktijkcijfers

source Milieucooperatie de Peel

The diagram of Vel and Vanla used in publication of nutrient management project Goede Grond, Sterke Koeien in Brabant (the Netherlands)

5. Making good manure on eight farms in the Netherlands

5.1. Introduction

My research at the VEL and VANLA Nutrient Management Project focused on collective knowledge production processes among scientists and farmers. I wanted to get more in-depth knowledge about the strategies and actions of individual farmers in the Netherlands that focus on making good manure on their farms. I was curious to find out what these farmers encountered while making good manure.[xxxi] This chapter portrays eight farmers that started to make good manure over the past few years. Section 5.2. describes the selection of the farmers and my role as a researcher during the interview process. It also presents the leading topics for this chapter, based on the questions that were asked during the interviews. Section 5.3. introduces the farmers and their motivations to make good manure. Section 5.4. describes the actions the farmers took to make good manure. The different actions are categorized into the two strategies derived from Eshuis *et al*. (2001: 21); improving the quality of manure and improving the utilization of manure[xxxii], and a first analysis of the strategies of the farmers is presented. Section 5.5. focuses on the indicators that the farmers used while making good manure. Indicators set values how to act at farm level according to the storyline of good manure. Section 5.6. describes the emergence of a range of experiential indicators that the farmers use while making good manure. Section 5.7. analyses the constraints the farmers experienced in developing making good manure. It interprets these constraints in terms of the increased tension between their farming practices and the dominant manure regime. Section 5.8. provides the conclusions of this chapter.

5.2. Material and methods

For this chapter eight Dutch dairy farmers were selected, who were known within the network of the VEL and VANLA cooperatives as innovative farmers. I needed a variety of farmers who started to make good manure and eight farmers deemed to be sufficient to guarantee diversity. Two networks proved to be useful; the first was the Nutrient Management Project VEL and VANLA, the second was the *Platform Minderhoudhoeve Ossekampen VEL en VANLA* (PMOV). With the help of Van der Ploeg, Van Bruchem and Verhoeven, I came to the following farmers; Boersma, Bloemhof, Douma, Berkhof, Kremer, Oosterhof, Scholten and Timmerman. Bloemhof, Boersma, Douma and Oosterhof were farmers that participated in the Nutrient Management Project of VEL and VANLA. Bloemhof and Timmerman were recommended as farmers that already were making good manure for quite some time. Van Bruchem advised Kremer, Berkhof and Scholten since he knew them from the PMOV.

The farmers have expressed their strategies and practices during two sequences of in-depth interviews. In the first interview, I asked the farmers to tell what actions they took in order to make good manure. There was common understanding about the storyline of good manure since this was part of the nutrient management projects we all were engaged in. I explained that I was interested in the particular ways they let the storyline of good manure influence their farming practices.

During the interview I presented the overall strategies and asked for the actions the farmers took and what they encountered in doing so. I asked them for the actions without a fixed list in mind and the action list grew along the way. The next set of questions dealt with the indicators the farmers used before they focused on making manure and the indicators they used after they started to focus on making manure. The final set of questions focused on the constraints and challenges they experience in their new actions to make good manure. During the second interview, the farmers evaluated the actions and discussed the adaptations they made. Reijs, a researcher in animal sciences was my fellow researcher during the meetings. His presence made the relation between animal feeding and good manure more clear, as he confronted his expertise with the expertise of the farmers during the conversations.[xxxiii]

5.3. Introducing the farmers that make good manure

The following table presents the years when the eight farmers started to make good manure. It also presents the nutrient management projects (VEL and VANLA and PMOV) they participated in.

Table 5.1. Start of making good manure and the projects the farmers participated in

	Boe	Blo	Dou	Ber	Kre	Oos	Sch	Tim
Start	'97	'90	'97	'99	'98	'97	'98	'92
Project	V&V	V&V	V&V	PMOV	PMOV	V&V	PMOV	PMOV

Bloemhof and Timmerman had a longer history than the other six farmers in making good manure. Both farmers were known by the other six farmers through the nutrient management projects. Bloemhof and Timmerman were the early initiators of the Nutrient Management Project of VEL and VANLA and of PMOV. Farmer Bloemhof started experimenting with new manure practices when he moved to Surhuisterveen in Friesland in the beginning of the nineties. At that time, he decided that the dominant regime did not represent the way he wanted to continue farming. He decided to change to an extensive farm strategy and he increased his acreage. Bloemhof used his own personality to show this discontinuation with the regime. He described himself as different and stubborn in comparison to other farmers in the Netherlands: 'I am a stubborn farmer. I listen to the people but do not necessarily act according to it.' He tried to maximize the utilization of silage and manure from his own farm and used low amounts of concentrate and fertilizer. He was very committed to make good rations for the cows via grassland management. He also was one of the first to experiment with additives. He was convinced that more indicators for the soil are needed because 'there are a million creatures in the soil, we hardly know anything about.' Farmer Timmerman was also actively developing new ways of making manure since the nineties. He considered it highly relevant that farmers developed their own skills in sustainable farming: 'The reduction of nutrient losses takes place through the improvement of manure and soil quality and by developing one's own strategy in feeding and manure.'

The other six farmers, Douma, Oosterhof, Boersma, Scholten, Kremer and Berkhof, all started to develop their strategies via participation in the nutrient management projects. Triggered by future environmental legislations, they aimed to decrease their nitrogen surpluses at the farm. Their motivation was to decrease the pollution from their farms and as a result gain a new 'licence to produce'.

Farmer Boersma from Twijzel in Friesland explained his participation: 'I want my farm to be sustainable, for the environment, but also for myself and my family.' That is why he decided to become a participant in the Nutrient Management Project of VEL and VANLA. According to Boersma, one of the key issues in making his farm more sustainable was by feeding less protein, as he has learned during the project. Boersma saw at a neighbour's farm that it was possible to reduce the amount of soy bean meal in the diet: 'There were some neighbouring farmers that stopped using soy bean meal without any negative effect on production. I saw that happen and decided to give it a go.' Boersma got to know Timmerman and Bloemhof very well and considered them to be the leaders in making good manure as they have changed their farms at an early stage and they established the projects.

Farmer Douma from Gerkesklooster in Friesland was also a member of VEL and VANLA. He did not share the same aims as Bloemhof (like making the farm more extensive) since he aimed for a high milk production per cow. He was convinced that also an intensive farming strategy and a high milk production per cow could be combined with better manure practices. At his farm, diet adaptations were mainly addressed by changes in the amount and type of concentrates. Furthermore he was very committed to learning about every detail of the nitrogen cycle.

Farmer Oosterhof lived in Eastermar in Friesland. Over the years, he had learned a lot from the stories of other farmers in the Nutrient Management Project of VEL and VANLA. Economically farming has become his main aim. He wanted to get a maximum of milk at the lowest possible costs. Focusing on making good manure fitted in this strategy because he could reduce fertilizer and concentrates and learn about the use of his own resources. Learning about the systems perspective was an important reason to join the Nutrient Management Project; he started to see that the changes he made in the diet towards low-protein were good for the cows and the manure production.

Farmer Scholten from Dalfsen in Overijssel focused on making good manure because he wanted the consumers to accept his farm. He therefore became a member of PMOV, where he experimented together with some colleagues. He lowered his milk production per cow, from 9000 to 7800 kg/cow. He also reduced the concentrate he gave to the cows.

Farmer Berkhof from De Wilgen in Friesland also started to experiment with having less protein and fertilizer, because of his participation in a study group of PMOV. He reasoned: 'When it goes well with the minerals, it goes well with the finances.' Based on the stories of others, he started to use EM to 'improve the quality of manure. He started feeding EM following the advice of the local EM advisor whom he considered to be an expert in the field of additives because 'he has a lot of contact with people who already use additives a long time and research institutes that perform research into it.'

Farmer Kremer from Stegeren in Overijssel became a member of PMOV and combined the different insights concerning nitrogen management he received from different advisors and working groups. He said to pick what fitted him most. He liked to calculate everything financially and wanted to achieve the 'highest milk production possible.' He decided to cut back on his fertilizer and protein use, but expressed to find it important that this was done in a balanced way, because he did not want to reduce his milk production per cow.

The eight farmers considered making good manure to be a feasible management option for their farming practice. The farmers used terms to categorize manure: good manure is manure that does not smell, is good for the soil and good for the cows. Timmerman phrased it in this way: 'When it really smells in the stable, the smell of ammonia, then you know it is wrong.'

During the interviews the farmers spoke in terms of farming systems. Repeatedly the farming systems approach was explained. The farmers started to see their farms as an interconnected set of practices, as shown by the following quote from Douma: 'The nutrient cycle has an important function in my ways of farming now. We want to focus on it, by increasing the optimal use of our own resources. The cow is no longer the centre, but part of a cycle'. The farmers spoke in terms of systems and cycles. They explained that the feeding had its effects on the manure that in turn had its effects on the soil that in turn had its effect on silage production and so on and so forth. Boersma called it the total machinery of the farm: 'Since I have applied other amounts of fertilizer I also feed differently. I used to have dark grass, the reason for that is that nutrient efficiency has changed. The efficiency was far too low, now with changing manure application and different ways of feeding, the whole machinery starts to work differently'.

5.4. Actions and strategies while making good manure

The eight farmers were selected because they were known by others to make good manure. The interviews have confirmed that they say they do. This section categorizes what actual actions they took in order to make good manure. These actions are clustered with the help of two strategies formulated by Eshuis *et al.* (2001: 21): improving the quality of manure and improving the utilization of manure. The tables present the actions that the farmers took as part of the strategy.

Actions that form strategy 1: improve the quality of manure

Table 5.2. Actions that the farmers took to improve the quality of manure

Actions	Boe	Blo	Dou	Ber	Kre	Oos	Sch	Tim
Less crude protein in concentrates	+	+	+	+	+	+	+	+
Less crude protein in the total ration	+	+				+	+	+
More fibre in ration	+	+	+	+		+	+	+
Improving quality of the silage	+	+	+		+			+
Less concentrates	+	+					+	+
Using additives		+	+	+	+	+		+
Adapting cow selection		+	+		+	+		+

Bloemhof and Timmerman took all the actions that are listed in table 5.2. as part of the strategy to improve the quality of manure. They have developed this coherent set of actions within their farming practice during the past ten years. The others were more selective in their actions. They did not take all the actions that Timmerman and Bloemhof carried out.

Most of the actions involve a change in the composition of the diet via the adjustment of either silage or concentrates. All eight farmers reduced the input of high-protein feeds such as soy bean meal. Boersma expressed this in a metaphor: 'I do not want to touch the soy bean meal button any longer'. He considered soy bean meal as one of the buttons he pressed automatically before he focused on manure. Now this has become a taboo. This is a powerful statement. It makes clear that he started to condemn his earlier routines. Automatically doing things for milk production was, in his way of reasoning, no longer valid.

The farmers considered the reduction of the amount of crude protein in the ration to be the most important measure for making good manure. Their way of reasoning was: less crude protein in the fodder means less nitrogen in the manure. Instead they started to focus on high-fibre diets. High-fibre diets were considered to be important for the digestion of the cows and to increase the Norg content of the manure. Oosterhof attributed an extra positive effect to diets with a higher fibre and lower protein content on the health of their cows: 'If you give less protein, the animals can deal better with the production. That is my impression'.

Boersma, Bloemhof, Kremer and Timmerman started to reconsider the importance of grass silage composition in the total ration. Grass silage became their basic feed. Concentrates were considered as an extra. They aimed to improve the quality of the grass silage to obtain more fibre, less protein and a better tastiness in the total ration. In order to increase the quality of the silage, they felt the need to obtain different types of grasses from the grassland, because these grasses improve the quality of the silage. Their preference became to have native grasses in the silage, whose presence were marginalized in the grasslands, as the following quote of Timmerman illustrates: ‘Our grasses need to be for 50% good grasses like perennial ryegrass, timothy or rough meadow grass. You need some other grasses but with too much cough grass or crane’s bill or marsh foxtail, the amount of fibre is too high.’[xxxiv]

Some farmers wanted to increase the quantity of silage fed, to be able to reduce the amount of concentrates purchased. For instance, Bloemhof preferred to feed as much grass silage as possible. This preference was the consequence of his deliberate extensification of his farm: ‘We went from intensive to extensive farming. When one is intensive, one exploits the cows maximally. That is not necessary now.’ To exploit this extensification, Bloemhof aimed at a maximum use of home grown grass silage.

Douma, Berkhof and Kremer on the other hand, did not reduce the amount of protein in the silage; since they wanted to be sure that the milk production levels stayed the same. They remained careful with the reduction of protein as expressed in the following quote: ‘If we go to extremes with reducing protein, our milk production levels can drop too much.’

Bloemhof, Douma, Kremer, Oosterhof and Timmerman have changed their cow selection. In the selection of cows new characteristics gained value, like the health and condition of the cow and the ways the cows were able to deal with the new rations and diets. The farmers were dissatisfied with the genetic make-up of the cows they had before. During the past few decades, cows were solely bred for milk production. Oosterhof said: ’It has become part of their genes to give themselves away.’ The farmers wanted to have sustainable cows with the capacity to digest large quantities of silage without any problem. Bloemhof said it clearly: ‘I want a silage cow and not a concentrate cow’.

One final action shown in table 5.2. is that additives were used by the farmers to increase the quality of manure and soil. More than half of the farmers used additives. According to Kremer, additives had a positive contribution to the effect of manure on the soil. ‘The past two years the soil has been visible again at my farm. I make use of EM and I think that the manure works better because of that.’

Douma made use of Euromanure mixture. He was convinced the additives change the manure and had found proof for that: ‘The smell is different, even people in the village say that they notice that difference.’

To summarize this strategy: The farmers have increased their attention to managing the composition of the diet. They abandoned the excessive use of protein in concentrates and changed the composition of grass silage towards higher contents of fibre and lower contents of protein. Part of this strategy was to adapt the cow selection to cows that were able to deal with these new rations. Another part of this strategy was to use additives to improve the quality of manure.

Actions that form strategy 2; improve the utilization of manure

Table 5.3. Actions that the farmers took to improve the utilization of manure

Actions	Boe	Blo	Dou	Ber	Kre	Oos	Sch	Tim
Less fertilizer	+	+	+	+	+	+	+	+
Broadcast surface spreading		+				+		
Improving soil life		+			+			+
Decreasing structural damage top soil		+			+	+		+
Higher frequency manure application	+	+	+		+			+

The different actions are clustered as the strategy to improve the utilization of animal manure. This strategy includes the actions that are conducted to improve the interactions between the manure and the grassland soils. Again it is visible that Bloemhof and Timmerman took all the actions of this strategy, except for broadcast surface spreading. Timmerman was not allowed to do use this type of manure application. Bloemhof was part of the group of farmers that was allowed broadcast surface spreading under the protection of the Nutrient Management Project of VEL and VANLA (see chapter 4).

Table 5.3. shows that the farmers all started to reduce the amount of nitrogen used by using less fertilizer. By reducing the amount of fertilizer they wanted to improve the utilization of the nitrogen that is delivered by their grassland soil. The amount of nitrogen in grassland that can be harvested without application of manure to the land is called the Nitrogen Delivery Capacity (in Dutch: stikstof leverend vermogen, expressed in the indicator NLV). The delivery of nitrogen is a result of the mineralization of Norg in the soil. In the following quote Timmerman explained the reason why he was of the opinion that more nitrogen could be gained from the soil after he reduced the amount of nitrogen via fertilizer: 'They say that only 50% of Norg can be mineralized. That is nonsense. I think it is 70–80 %. Organic nitrogen is not mineralized when you use a lot of fertilizer that ruins your soil life but if soil life can function optimally, including moisture content and structure of the soil, mineralization can be optimal and than the organic nitrogen will be available for the plants.'

The farmers have tried to increase this mineralization by a series of actions. They argued that soil biota must be stimulated to convert Norg to be available for plant uptake. Therefore they took actions to stimulate microbial processes in the soil and to reduce soil damage in many ways. Therefore some of the farmers started to look different at the effects of machines on the structure of the soils.

Bloemhof warned that one should 'Not use too many tractors on the grassland. We still have to fetch the drinking unit, but we wait until it is dry.' Bloemhof and Oosterhof were allowed to maintain broadcast surface spreading instead of shallow injection because they were involved in the Nutrient Management Project of VEL and VANLA (see chapter 4). They considered shallow injection to be damaging for soil life. One other advantage of broadcast surface spreading was that by the use of smaller machinery one could avoid soil damage. While using broadcast surface spreading, they gave smaller amounts of manure while increasing the frequency of manure application.

Oosterhof started to apply manure as early as possible: 'With slit injection you can apply manure only at the end of March and that is one month later then broadcast surface spreading. Especially when spring is mild, you have a lot of profit from broadcast surface spreading.'

Bloemhof varied the amount of manure he applied on the various parcels to improve the utilization of manure. He reasoned: 'There are parcels who do not need manure at all and others who need more manure. That also depends on the soil. Sandy soils need more manure. It also depends on the age of the soil, if it has been ploughed recently. Then it needs more manure.'

Douma did not apply too much manure at once: 'After every cut or grazing, we apply manure. Not too much, as little as possible, spread over the year. Before the first cut, we apply a large amount of manure and later on, just ten cubic metres after every cut. We are very pleased with this method.'

To summarize this strategy: While reducing fertilizer input, the farmers aimed at an increased utilization of slurry nitrogen and soil N mineralization. The actions they took focus on a stimulation of soil microbial processes by avoiding structural damage to the soil through shallow injection and a better distribution of manure.

5.5. The significance of indicators for making good manure

In the interviews, the farmers were asked for the relevant indicators they used before they focused on making manure and the indicators they started to use while making good manure. I also asked them to reflect on the way they used them in their strategies while focusing on manure. The following section analyses the new indicators that emerged in the storyline of making good manure. Below two diagrams are presented that summarize the use of indicators at the eight farms. In figure 5.1. the indicators are presented that were dominant until the end of the nineties. In figure 5.2. the indicators are presented that were used by the farmers that make good manure.

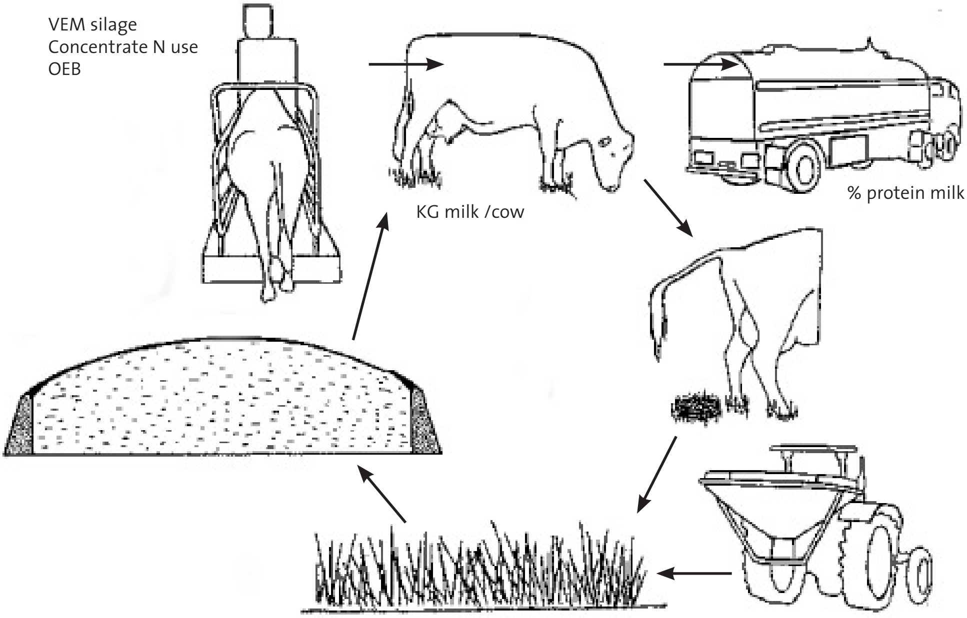


Figure 5.1. Indicators that happened to be used in the prevailing manure regime

In figure 5.1. milk production per cow (KG milk/ cow) and the amount of protein in the milk (% protein/ milk) are presented as the most important indicators that farmers used to monitor their goals in milk production. A high energy content in the silage, expressed as VEM silage, guaranteed them that they could achieve a high milk production. Kg KVEM/ha and % protein milk were used as indicators for the productivity of the farm.
During silage production the aim was to produce silage with maximum energy content (VEM) in order to be able to reach that high milk production. VEM is a calculation based on the amount of protein, sugar and the digestibility of the ration. When one cuts the grass early in combination with high nitrogen input, VEM becomes high. When one cuts the grass at a later moment, this results in 'slow' silage, with less protein and lower VEM.

The percentage of nitrogen, expressed as Concentrate N use, and a surplus of protein in the ration, expressed as OEB, were representative indicators that the amount of N was abundantly available. The amount of fertilizer used was also important, and expressed as Fertilizer N use. Advisory schemes and educational principles were based on the use of as much fertilizer as possible. Animal manure was treated as a waste product that could be applied as much as possible. There were no indicators that monitored the quality of manure.

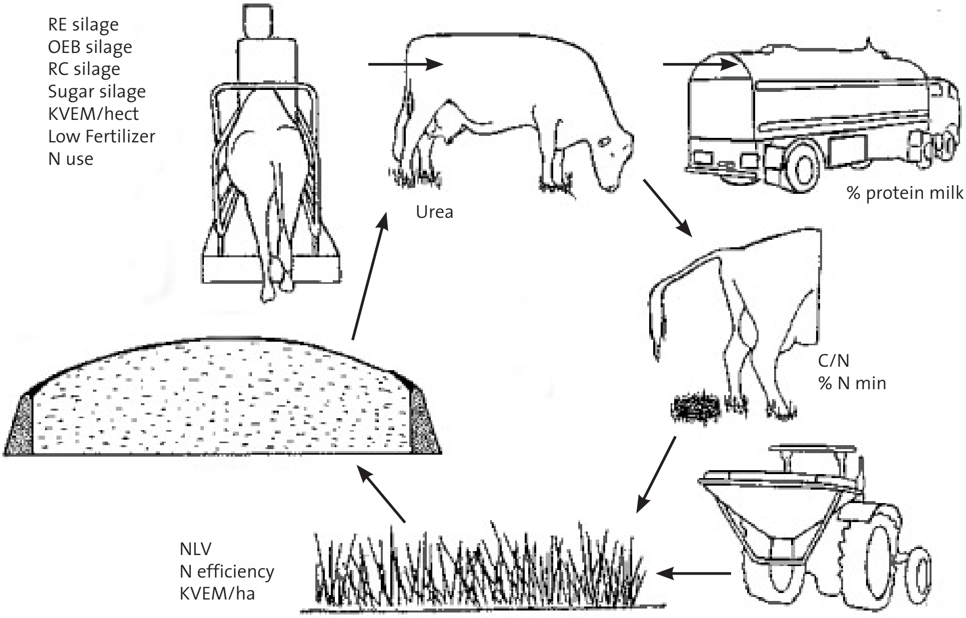


Figure 5.2. Indicators that are important in the storyline of making good manure

In figure 5.2. a series of changes is visible, compared to figure 5.1. Indicators of figure 5.1. have lost their value. One indicator that lost its value is the milk production per cow (Kg milk/cow). There is also a group of indicators in figure 5.1.: Fertilizer N use, Concentrate N use and OEB that have a negative meaning in figure 5.2. In figure 5.2. a low use of inputs expressed in low fertilizer N use, Concentrate N use and a low OEB in the diet have exactly become indicators of good farming. Two indicators from figure 5.1., KVEM/ha and % protein milk, indicate the productivity of the farm and therefore have kept their importance in figure 5.2. as well. The difference however, is that they have to be balanced with other indicators that enter figure 5.2.

In figure 5.1. indicators for soil and manure are not present and not relevant. In figure 5.2., there is a whole range of indicators that represent the goals of the farmer to work well with his own resources. Several indicators represent the quality of manure; C/N ratio and %Nmin (which reflects the percentage of Nmin content in the manure). Several indicators represent the condition of the soil; NLV and N efficiency. One of the indicators often used is the Nitrogen Delivery Capacity (NLV). It is an indicator that represents the mineralization of the soil. NLV is based on an estimation of the amount of Norg available in the twenty centimetres of topsoil.

The indicators for the ration have changed significantly in figure 5.2. In figure 5.1. the main aim for the composition of the ration is maximum milk production, expressed in VEM. In figure 5.1. a low VEM is an indication of bad silage, in figure 5.2. it is an indication of good silage. In figure 5.2. a range of new indicators of good farming popped up that are equally important to VEM. These indicators are OEB, RE and RC. As said before, OEB is a direct indicator for the surplus of protein in the diet. Low OEB can be reached by a low OEB in the silage. This can be achieved by lowering the nitrogen input in grassland and making the silage as dry as possible. RE stands for the amount of protein in the total diet, RC stands for the amount of fibre in the total diet.

In figure 5.1. the cow serves as a tool to produce as much milk as possible, which is reflected in the indicator 'milk production per cow'. In figure 5.2. this has changed: the production reaches a limit. In figure 5.2. urea is used as an indicator that the farmers use to evaluate the effect of the feeding strategy on the manure. When the urea content in the milk is low, it means that there is a low amount of protein surplus in the ration. When the urea content is high, this indicates that too much nitrogen gets lost and the ration was too rich in protein.

The indicators served as management tools, to monitor and improve the nitrogen efficiency at the farm. For instance, Berkhof used the values of the indicator 'urea' as a warning that he had to change something in his feeding practice. He considered it a warning that nitrogen is not efficiently used. High urea content also has a relation with the manure: the manure contains more nitrogen and the ammonia emission is too high. Berkhof explained it in this way: 'Urea is an anchor. If it is low, between 20 and 25 and the cows produce well, then all goes well. If urea is a bit higher, the cows produce more thin manure and I expect trouble.'

Douma makes use of the C/N ratio as an indicator for the management of his farm. 'We work with the C/N ratio. Now we have manure close to a C/N ratio of 9. That is high; the figure to strive for is 10. At the APM, they had 13. We do not want to go that far, but the maximum of 10, we do want to reach. We hope that we can prove that in that way we produce less ammonia and we hope that we convince the government this is the right way.' He explained that he would use the figure as proof for his way of farming. He based this evidence on the results of the APM (see chapter 4). For this purpose he had developed knowledge about the relation between the figure and the quality of manure. In his view, a C/N ratio of 10 is an indicator of manure of good quality. When the indicator scores correctly, it is a sign that he has acted according to the storyline.

The farmers needed new indicators to monitor the processes. What they wanted were indicators that reflect the quality of their actions to make good manure. The farmers emphasized that there is a crying need for clear indicators that represent the functioning of the soil. Boersma stated: 'If you use other manure, what happens to the soil? What are indicators for good soil? Norg content, microbes, worms: how does it work? That is the question for the next 15 years.' Therefore it is not only important to look at indicators that represent nitrogen delivery (which is now expressed in the indicator NLV), but also to take into account the role of other factors, like microbes, fungi, pH and water content as Scholten argued: 'Yes, the soil, look they measure Norg content, but some sort of health index for the soil does not exist. It is not known.'

The indicator NLV is limited, in the opinion of the farmers. All top soils with a Norg content of more than 0.3 percent have an NLV of 200. When one works on measures to increase nitrogen delivery, this cannot be part of the calculation, as Boersma explained to me: 'NLV stops at 200 in the calculation, but perhaps it is more. So, when you apply fertilizer according to this model, you may have the wrong starting point. That is like shooting in the dark.'

This section shows that there is a range of new indicators that the farmers started to use, while making good manure. The values of these indicators are guidelines on how to act at farm level according to the storyline of good manure. The farmers tried to reach these values and in this way, indicators served as a monitoring tool in the farming practice to integrate the storyline of making good manure. Indicators became important bridges between the day-to-day practices and the new storylines.

The indicators (C/N, RE, RC) are entities that refer to other entities (good manure, good grassland). For example, the C/N ratio of manure is an indicator that represents the quality of manure. A large part of the narrative of good manure is converged into this indicator. It is a quantitative standard for a qualitative description of manure. The C/N ratio is more powerful than 'high quality' because it represents 'objective science.' The level of the indicator represents a value on the scale of good or bad manure. It summarizes the efforts of the farmers to make good manure. The farmers used these indicators as monitoring units for pursuing their strategies. For some of their activities, especially concerning the understanding and monitoring of the grassland soils they needed more indicators.

5.6. The role of experiential indicators in making good manure

This section describes a range of experiential indicators that emerged while making good manure. Experiential indicators also served as monitoring devices. But the farmers have different opinions about the status of experiential indicators compared to quantitative indicators, as presented in the previous section. This discussion shows a new element of the role of indicators. Some of the farmers considered indicators to be necessary to prove that what they were doing was right. Here the second role of indicators appears; they serve as epistemological devices to make the storylines become more manifest.

The farmers started to make more and more use of experiential indicators. Their own experiences and observations gained in importance, while monitoring making good manure. The quantitative indicators were not sufficient for the new domains they needed to learn about. Before they made good manure, gaining knowledge of grasslands, soils, cows and manure was not considered to be that important. Now the development of this knowledge had become more important.

Farmers started to use their own observations and experiences like smell, sight and touch when making good manure. Berkhof told that he started to watch the manure and ask himself questions like: 'Is it thick or thin manure? How does the manure smell and how is the fermentation process of manure?' With the silage, the farmers also used their own observations. The farmers started to observe the silage intensively for colour, smell, taste and texture, to evaluate diet composition and draw conclusions on the digestion of the animals and the quality of manure. For example, the farmers observed that the grass had become lighter. They considered the colour of the grass to be an indication for protein. It used to be important to have dark green grasslands. But now it had become important to have light green grasslands as Boersma stated: 'Less fertilizer use implies other feeding. I used to have dark grass, now it is lighter. It has to do with the utilization of nitrogen, which was much too low. Now it is starting to work, with less fertilizer and different feeding.'

Douma told about the way he used his experiences. He told that when he once applied manure to the grassland at the same time that his neighbour applied manure, he observed that the seagulls went to the neighbours to eat the worms. 'For me that is proof that the worms in my soil do not try to get away from the manure. My manure is less polluting than the manure of my neighbour.'

There are differences among the farmers in the ways they looked at these experiential indicators. Bloemhof and Timmerman considered their own experiences as valid to use in the management of their farms and they relied on their own measurements. Douma and Berkhof on the other hand, explained that scientific evidence is needed for their own experiences. They did not always trust their own senses as a good instrument and they knew that others did not consider their eyes and ears to be reliable instruments.

Farmer Douma repeated several times that measuring should take place at a detailed level and with objective devices. This is also reflected in his own feeding strategy in which he watched every detail of the nitrogen cycle and looked at the influences on the condition of the cows. He has invested a lot in measurements, for instance in blood and milk scores, to have a grip on the management of his new feeding strategy. He stated: 'The more you measure, the more you get close to the truth. When I measure how much rain has fallen, I know the amount of millimetres.'

Apart from the fact that scientific measurements might help to improve the production process, he was convinced that scientific measurements were needed to convince other people that the chosen strategy was the right one. For instance during the interview, but also at meetings of VEL and VANLA, he expressed time and again that it was, in his opinion, crucial to have proof of the strategies being good and true: ‘‘We cannot really prove that what we are doing is true. People shrug their shoulders and even say: it only costs money (using additives, M.S). We cannot prove it; I can only say that there are certain things I know. But people want to see indicators and numbers.’

So in the use of experiential indicators, there was a clear difference among the farmers. The first group took experiential indicators seriously, in developing the strategies. Others wanted more scientifically measurable causalities between the storyline of good manure and the management tools that they started to use.

5.7. Good manure and old regime

During the interviews the farmers expressed several constraints while making good manure. While they mentioned these constraints they highlighted their views and opinions on the regime that their farms are embedded in. This section is a categorization of the constraints they mentioned and the ways they found to overcome these constraints.

The first type of constraint they mentioned is the limited adaptability of cows to other aims besides milk production. The farmers expressed that the availability of cows that are adapted to the practice of making good manure is limited. The farmers had experienced this over the years when they started to focus more on the production of manure. The farmers wanted cows that could eat large quantities of silage and not have the highest milk production. Therefore they started changing their own selection schemes, but it was not always easy to find the right cows. Bloemhof found it difficult to breed the type of cows that he needed for making good manure. For example, Dutch Frisian cows were a type of cows that were difficult to buy. Timmerman and Oosterhof were concerned about the lost of old breeds. Timmerman stated that he was afraid they might not be able to go back to the old pattern of breeding: ‘Old breeds are not available anymore.’ Oosterhof suggested: ‘You need to buy cows at an extensive farm with a large number of cows, in which the animals need to prove themselves. If you buy them at a farm with a very high production, you need to fine tune the feeding systems and go for maximum production. That type of animals are spoilt, I do not want that in my herd.’

The second type of constraint deals with their use of technologies and the availability of technologies. One example the farmers mentioned is manure storage. In building their farms, the manure storage was designed in such a way that large quantities of thin manure could be stored, to be spread regularly on the land. Now, with the new strategies, manure has become a valuable resource. They did not want to dump or sell their manure but they wanted to apply it at their own farm in the right amount at the right moment. Therefore they had to make sure that they had enough room to store manure through the year.

The third type of constraint relates to the reward structures for their ways of farming. The reward they get is expressed in the price they receive for the milk. Farmers get paid for the protein content in milk. With the feeding strategy to make good manure, it is more difficult to have high protein contents in milk. The farmers expressed that the protein content had to be high enough. Scholten mentioned that his farm is different from an experimental farm, like the APM farm that did not have to deal with the protein content in the milk: 'At the APM farm we see the perfect example... except for the protein content. That is my main concern.' He was not in a position to experiment with all measures on his own farm, as the APM farm did, as it might have had negative effects on his income. With this statement, Scholten expressed the overall feeling of the farmers. They wanted to experiment with making good manure, but they could not behave like scientists in a laboratory of a field station. They still had to take into consideration that they dealt with a real-life situation, which they earned their income from.

The fourth type of constraint deals with legislation; the farmers were obliged to use slit injection of manure and to put manure on the grassland in certain periods of the year. They regarded this regulation as an obstacle for the full operation of their strategies. They especially considered slit injection to be bad for their grasslands and soils (see chapter 4 and 6). For example, Timmerman decided to acquire a machine that he had adapted to his strategies while it was legal to use: the machine was a shallow injector that was fine-tuned not to damage the soil.

The list of constraints shows that making good manure could not be separated from the dominant food and manure regime. The constraints (as the farmers experienced them) were still part of their actions. Farmers questioned these constraints, but within their practices they often still had to incorporate these constraints. There was an increased tension between their farming practices as a space where good manure is developed, while at the same time the farmers had to operate in a dominant regime that was not aligned with the practice of making good manure.

5.8. Conclusions

The farmers in this chapter changed their nutrient management practices during the last decade. The farmers narrated about these nutrient management practices in terms of making good manure. They aimed to make good manure and therefore adapted their management practices.

The eight farmers implemented eight different ways of making good manure, adapted to their own individual farms. All of them drastically reduced the inputs of proteins in the diets of the cows. Some of the farmers used additives to make better manure. Others wanted silage with more types of grasses in the diets and machines that support soil life, and some of the farmers focused on having cows that are able to digest the new diets. Making good manure is integrated in the design of the farm. This results in different management options for different farmers, leading to a great variety of farms.

Soil, plant and animal are balanced by improving the quality of manure and improving the utilization of manure.

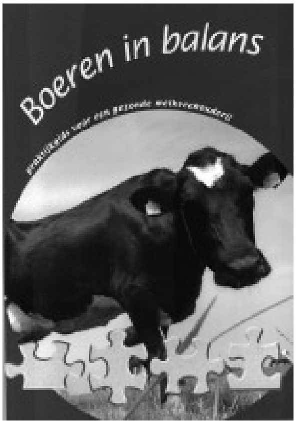
The nutrient management projects served as important regional networks since the farmers exchanged information about making good manure and they learned from other farmers in doing so. Two farmers were considered to be representatives of the storyline of making good manure, partly because of the fact that they started making good manure earlier on and were founders of the nutrient management projects the others participated in.

The farmers reasoned in terms of nutrient cycles and farming systems. They wanted to achieve a balance at the farm in such a way that their farms functioned as a whole. While they worked on one detail, they look at the effects of this action for the rest of their farms. For instance, the quality of the ration is considered to have effects on the cows, manure production and milk production. Farmers' knowledge is referential knowledge; farmers know their soils through the grassland production, they know the grassland through the effects on the animals, they know the cows through the manure and they know the manure through the grassland production. In other words; the farmers make local variations of the soil-plant-animal system. The farmers try to develop insight into the own specific character of their soil-plant-animal system and dynamic relations with local conditions and available growth factors.

The farmers attributed different roles to indicators in their management practices. The first role of indicators is to give the farmer the opportunity to consider whether the aims of his agricultural production are achieved in the proper manner. The values of the indicators set standards on how to act while making good manure. The farmers used indicators as monitoring units for pursuing their strategies. In their use of these indicators they experienced a lack of indicators that could support their management decisions; not enough knowledge is available to understand how the soil and manure actually work. The farmers also attached new importance to a range of experiential indicators they used to observe their soils, cows and manure. The farmers attributed different roles to the experiential indicators. Some of the farmers found these experiential indicators sufficient for the management of their farms while other farmers found experiential indicators too weak. These farmers also wanted new indicators for soil, cows and manure that they could use to prove that what they do was right. Here the second role of indicators appears; these farmers considered indicators to be useful epistemological devices to make the storyline of good manure become more manifest.

The farmers faced several technological and institutional constraints while making good manure. Their farming practices cannot be separated from the dominant food and manure regime in which they operate. Specific constraints (from the viewpoint of their strategies) influence their actions. To let the storyline of good manure fully evolve at farm level, adaptations to technologies and institutions of the dominant regime are needed as well.

Publications



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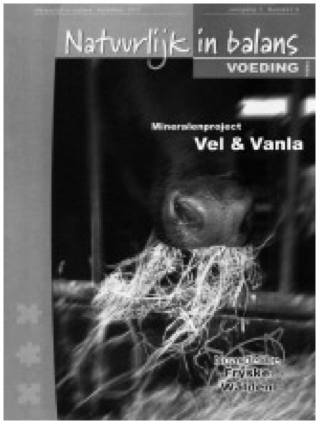

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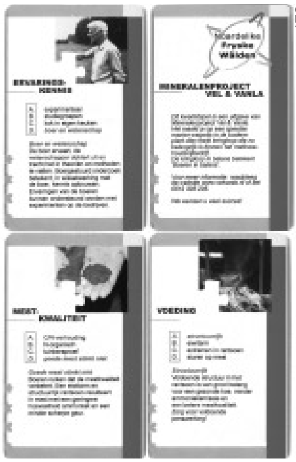

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National News

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Landscape of the Vel and Vanla area on the national news

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Farmer Hooisma in front of his cattle during the national news


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Vel and Vanla on the national news 20th of September 2003

source NOS

Scientist Brussaard presents the results of the Nutrient Management Project on the national news

6. Narrating good manure for regime change

6.1. Introduction

This chapter follows the narrators of the storyline of good manure in their activities to transfer the storyline of good manure to other places and put it in the wider social and political context (Weber *et al*., 1999), thus aiming to establish a regime change. Section 6.2 describes the materials and methods this chapter is based on. Section 6.3. looks at the attempts of the farmers of the Nutrient Management Project of VEL and VANLA to get a separate governance status in Dutch legislation. Section 6.4. looks at the attempts of the narrators of good manure to change the existing policies on manure application technologies. The farmers and scientists involved in the Nutrient Management Project of VEL and VANLA were followed in their opinions why they did not agree with this law and the ways they mobilized agency and entered a wider network to achieve that other types of manure application would be allowed as well. Section 6.5. looks at the attempts of the narrators of good manure to change the volume policies. The farmers and researchers formulated an alternative to the present law on manure excretion and aimed to clear the way for this alternative in the current policies. Section 6.6. shows how the actors aimed to disseminate and transfer the different storylines to the scientific and farmers' communities, respectively. Section 6.7. provides the conclusions.

6.2. Material and methods

For this chapter the actors were followed in their attempts to incorporate the storyline of good manure in manure policies and to transfer the storyline of good manure to other places. Apart from documenting the steps the actors made, articles, journals, interviews and laws were examined as well.

I have performed an in-depth literature study. I read governments documents and scientific reports that dealt with the issue between 1990 and 2006. Literature research was performed into the origins of law on manure application technologies and volume policies. The relevant documents were EC documents (EC 1991; EC 2001) and Dutch Acts (Ministerie LNV, 1998). Documents from the Dutch Parliament about the application policies and the volume policies were used. Journal articles were used that described the various standpoints.

I interviewed members of the Nutrient Management Project of VEL and VANLA about their attempts to influence the volume and application policies. The study meetings and the research council meetings of the Nutrient Management Project were used in order to get insight into the opinions of the members of the Nutrient Management Project. Interviews were held with Van Bruchem and Verhoeven about their proposed alternatives for the law on manure excretion.

6.3. The activities of VEL and VANLA to get a separate status in government regulation

The farmers of the environmental cooperatives of VEL and VANLA and some scientists of Wageningen University and Research Centre worked together to get a separate status within the application policies that the Dutch government issued.[xxxv] As discussed in chapter 3, high ammonia emissions led to legislation that required manure application by shallow injection. All the Dutch farmers, including the farmers of VEL and VANLA, were obliged to use these technologies. The environmental cooperatives had intensive contacts with representatives of the Dutch government to negotiate on a separate status to achieve the environmental aims concerning nitrate losses. In the period between 1990 and 1995, when legislation on manure application that required shallow injection of manure was introduced in the Netherlands, the environmental cooperatives VEL and VANLA negotiated on exemptions with the Ministry of LNV concerning their methods of manure application.

The farmers of the environmental cooperatives VEL and VANLA had different arguments why they considered shallow injection of manure inappropriate within their landscape of hedges and belts of elder trees. First of all, they argued that within their own approach to the ammonia problems (framed as the storyline of good manure), it was not needed to abandon broadcast surface spreading. Secondly, the farmers of VEL and VANLA also found that shallow injection created problems, especially on lower-lying land and in the open meadows. They found it very difficult to work with these machines within small fields. Thirdly, because of high water levels in spring, the use of the heavy machines had damaging effects on the structure of the soil. This meant that the farmers had to use more fertilizer to achieve the same results (which was bad for their nutrient balances). The farmers became concerned that farming in harmony with their specific landscape of hedges and belts of elder trees would no longer be possible, since the only viable way of using the machinery would be to enlarge the fields, thereby damaging the landscape (see Wiskerke *et al.*, 2004).

At that time, different groups of actors started to criticize the overall approach of the Dutch government expressed within the environmental policies. The argumentation was that, what they called, the 'one-recipe-for-all' method did not work. Instead there should be regional diversity in regulation. Regulation should be developed in cooperation with farmer's organizations and cooperatives. This debate was in line with the discussion on governance during these decades. The argumentation is that governing (taking care of the collective issues in society) takes place by more actors than governments alone. One should concentrate on improving the cooperation between all relevant stakeholders that have a share in making and governing policies (Stuiver and Wiskerke, 2004).

In line with this, the Dutch Ministry of LNV started with a 'governance experiment' in 1995 in which five environmental cooperatives were given incentives to take responsibility for preserving nature, landscapes and the environment within their areas (Anonymous, 1996). The different environmental cooperatives (including the cooperatives of VEL and VANLA) were given a free rein to formulate their own ways to meet the sustainability demands. The activities of the farmers were intended to be as practical as possible, addressing the themes of nature, landscape, environment, as well as water management and recreation. Therefore close relations were maintained with the relevant authorities and organizations. Working groups were built dealing with the different themes and all the stakeholders contributed to developing the plan of action (Renting 1995). The result was that twenty farmers of VEL and VANLA received permission for broadcast surface application of manure. Agreements that manure could be applied fourteen days later than the national norm of 15 September were also made. In return the farmers committed themselves to meeting the nitrogen loss standards (see Table 3.2.) more quickly than the government required.

The negotiations between the stakeholders about manure application technologies changed direction when, in 1999, the Nutrient Management Project of VEL and VANLA was set up. At the same time, the evaluation of the governance experiment in 1999 put an end to the possible shift towards local governance. Although the Minister of Agriculture, Nature Management and Food Quality assured Parliament that the governance experiment was to be continued, it was decided at the same time that the environmental cooperatives would not receive an official governance status.

'My plans concerning the 'governance experiment' are contained within this letter. [...]. With regard to the quality aspects for the maintenance of the elder trees, I will ask the Province of Friesland to develop this as an experiment within the national programme of landscape maintenance. [....] The permission to apply manure after the 15th of September can be given under specific conditions. I will support your experiment in reducing mineral losses. I ask you to make a research proposal for 1998 until 2000, together with the scientific institutions of the Agricultural University of Wageningen and the Research Institute for Animal Husbandry. Your research into additives will be part of this research. Under these conditions, broadcast surface spreading of manure can continue.' (Van Aartsen 1998: 1).

Broadcast surface spreading was allowed only as part of scientific research. The report of a visit to the Frisian Woodlands from the Ministry illustrates that the government was, at that time, careful in taking a position, both in nurturing the VEL and VANLA cooperatives as a niche, and in deviating from generic rules in the manure application policies. 'Annemarie Burger[xxxvi] is convinced that leading organizations in dealing with sustainability, like the VEL and VANLA environmental cooperatives, should be protected. At the same time, we know that it is difficult for governments to deviate from generic regulations. That is why this is formulated carefully in the policies concerning agricultural nature groups. The exemption from the obligation to apply slit injection of manure is only legitimate and defendable for scientific purposes' (Bargerbos 2001: 1)

As described in chapter 4, the farmers and scientists started to experiment with knowledge activities on application technologies as part of the Nutrient Management Project of VEL and VANLA. In this way they gathered more proof for their claims that broadcast surface spreading was legitimate. The following section describes what actions the farmers and scientists took to change the Dutch policies to give free rein to this technology.

6.4. The activities of VEL and VANLA to alter the policies on manure application

Those who proclaimed the storyline of good manure wanted to change the manure application policies in the Netherlands towards making broadcast surface spreading legal again. In this section it will become clear that different evidence was used within the growing network, to create a stronger version of the story of good manure. Or, in the words of Van der Ploeg: 'The stories of the farmers, the animal scientists, the soil scientists and the social scientists all have their own messages, but when these are combined, they get more significance in the context of agricultural policies.'

Through several research activities, the farmers and scientists developed different arguments to make their claim. In the beginning, the farmers based their claim on their own experiences with manure application. Based on the farmers' observations and strategies, the researchers started to develop research activities into manure quality, ammonia volatilization and soil life.

The first argument was based on the research of Huijsmans *et al.* (2004). It was argued that broadcast surface spreading should be allowed to those farmers that make manure based on low-protein and high-fibre diets. This manure volatilizes less ammonia and with the right measures taken, it is not harmful to the environment. The field trial of Huijsmans *et al.* (2004) as well as the research of Van der Stelt (2007) provided evidence for their argumentation. It shows that ammonia volatilization is a function of the amount of Nmin in the manure. So manure quality can be indicated on the basis of the amount of Nmin.

The second argument the farmers emphasized, was that emission was influenced by the ways the farmers used the technologies in the application of manure. The farmers argued that it was important to look at the amounts of manure applied, as well as the time and weather conditions under which to apply. Research of Huijsmans *et al.* (2004), Bouma and Sonneveld (2004) and Sonneveld and Bouma (2005) was used as evidence for this claim.

The third argument was related to soil life. It was argued that shallow injection is bad for the structure and the microbes in the soil. The research of de Goede *et al.* (2003) provided evidence for this claim. The effects of manure application on microbes in the topsoil were researched and it was stated that the worm populations that are the most important to the condition of the soil, are most vulnerable to shallow injection. These worms also are exposed to a high salt content in the topsoil, which is also damaging for the soil. More of these worms live where manure is applied by broadcast surface spreading (Goede *et al.*, 2003).

The claims the research council of the Nutrient Management Project of VEL and VANLA made became clear in a heated discussion with De Boer, a dairy farmer from Conjum and one of the leaders of the farmers organization LTO in the North of the Netherlands, as well as a member of the Board of Friesland Dairy Foods. This farmer severely criticized the research results that were communicated by the members of VEL and VANLA in their magazines and articles. He sent a letter to the Board of Directors of Wageningen University and Research Centre, in which he requested for an investigation of the research procedures and knowledge creation processes in the Nutrient Management Project, as shown by the following quote: 'No claim that is made by VEL and VANLA is scientifically proven. Even worse: it is rightfully untrue. Because of the great societal demand and because the outcomes comply perfectly with what we all want, the continuous flow of publications gives a wrong image of what happened at the project, and other projects need to put a lot of energy in explaining why their efforts are also good to reduce environmental burdens. That is why I ask you to do a research into the theories of Van der Ploeg and Van Bruchem.'

One of his criticisms related to the claim of the farmers that broadcast surface spreading was legitimate: 'Mineral use with band spreading of manure: most of the experts say that this is not true'. The criticism of De Boer was discussed in January 2004 in the research council, and an official response from the research council was sent to De Boer and Wageningen University.

The letter of the research council stated that, on the basis of the accumulation of results developed in the Nutrient Management Project, manure with a lower amount of Nmin and a higher C/N ratio could be called better manure. In this letter, several arguments were made to make the storyline of good manure more robust. The amount of mineral N per cubical meter was said to be an indication for manure quality. The research of Huijsmans *et al.* (2004) was also brought forward as proof that ammonia emission shows a relation to the amount of Nmin in the manure. Another indicator for good manure that was mentioned in this letter is the contribution to plant growth. A calculation showed that manure with a high C-N ratio can give the same grassland production as manure with a low C-N ratio. This conclusion was based on a research performed by a group of researchers under the supervision of Groot *et al.* (2003b) from the Department of Organic Agriculture. They had explored the flows of nitrogen within the soil-plant-animal system. In this analysis the researchers aimed to integrate the processes of nutrient input, recycling, immobilization and mineralization (Groot *et al.*, 2003b). Groot defined recycling as the mineralization of Nitrogen over the year and its incorporation into herbage, which occurs by release from faeces, animal urine and non-harvested biomass (*ibid*). The research concluded on the basis of the soil-plant-animal system that improvement of internal nutrient recycling would contain promising solutions for the future (*ibid*).

The farmers and scientists of VEL and VANLA were not the only ones that were convinced that making good manure from the systems perspective would allow broadcast surface spreading to be sufficient to deal with the nitrogen losses. In 2002 and 2003, there were several court cases in the Netherlands in which the judge decided that several farmers were guilty of breaking the law of manure application. One example of a man that went to court several times is farmer Spruit (Cort, 2004). In 1995 he got a fine for surface application of manure. In 2002 he was convicted but no punishment was imposed. He asked for an exception to the rule, but was not allowed to.

Farmer Spruit became famous because several well-known figures adopted his vision and novelties. Van Zomeren, an established Dutch author and critic wrote about Spruit's farm in several newspapers (Van Zomeren, 2003). 'Loss of manure in groundwater is something that does not take place at Spruit's farm. He knows that by looking at the transcendent water with plants and fish. He considers shallow injection of manure as an act of violence that is not needed at all' (*ibid*). The known actor and ambassador of 'The Green Heart' (in Dutch: *het Groene Hart*)[xxxvii], Van der Vlugt dedicated time to him. He wrote a manuscript about the farm, in which he pleaded for more room for experimentation of the method of Spruit (Van der Hoek, 2003; Van der Vlugt 2001). Both writers described Spruit as a farmer who is close to nature and idealistic, with a flourishing farm (Anonymous, 2003a). Several journals dedicated an article on the subject matter of manure application (Ellenkamp, 2003; de Kort, 2004; Anonymous, 2003a; Wassink 2003)

In May 2003 several researchers including Van der Ploeg, Van Bruchem and Brussaard met Van der Vlugt and decided to send a letter to minister Veerman of LNV to explain and ask for more room in legislation in the favour of farmers that have shown to make good manure and who would be allowed to use broadcast surface spreading of manure. A discussion started in the Journal of Wageningen University about the subject (Van Maanen, 2003a; Schröder *et al*., 2003).

In his letter, Van der Vlugt argued that the government mixed policy means and policy goals. Some farmers meet the goals set by MINAS by focusing on making good manure and good soils, but do not want to implement the policy means of the government. Van der Ploeg stated: 'Give them free rein to meet the ends on their terms and do not punish them for meeting the ends. Of course these farmers need to prove that their methods are sufficient' (Van Maanen, 2003a: 3). Brussaard argued that farmers want to choose the approach that fits their farms: by adjusting diets and soil life improvement they want to aim for nitrogen efficiency (Wassink, 2003).

A group of scientists opposed the claims made by Van der Vlugt's letter (see Schröder *et al*., 2003; 17). They argued that shallow injection of manure has proven to decrease ammonia volatilization at farm level. The measures the composers of the letter considered to be a good alternative for shallow injection, did not amount to the same reduction of ammonia volatilization. They argued that this policy of shallow injection might be a means instead of a goal, but that the letter of Van der Vlugt did not present a good alternative that might be measurable. They argued that achieving the norms of MINAS was not a good indicator since in reality the N losses on these farms are higher than MINAS indicated. Furthermore they stated that it is not proven that abstaining from shallow injection would improve the N efficiency at the level of the farms, nor that grassland with more Norg and more soil life would compensate for the nitrogen losses caused by broadcast surface spreading.

Members of Dutch Parliament asked Minister Veerman questions, and he came with a proposal to investigate the matter at the end of 2003. The Minister decided to grant time and money to a two-year experiment in which the farm of Spruit was object of a research into environmental quality of the farming system. Therefore he received exception to the rule of shallow injection. Measurements were done in 2004 and 2005 (Bouma and Sonneveld, 2004). The aim was to monitor the farming system of Spruit and investigate whether it was a viable alternative to achieve the aims set by the government.

The results of this research in 2005 supported the storyline of good manure. The first conclusion the researchers drew was that a strategy of protein-poor feed and use of fibre can substantially reduce the production and losses of ammonia. In combination with broadcast surface spreading, this strategy did not volatilize more ammonia than shallow application of manure that did not embrace the feeding strategy. One other conclusion the researchers drew is that ammonia loss through broadcast surface spreading is very dependent on weather conditions (Sonneveld and Bouma, 2005: 7). One of their recommendations was that a working group should investigate whether there is a possibility for the government to allow broadcast surface spreading for manure with less ammonia on a larger scale. In their report, they emphasized that clarity about this governance issue is needed because the discussion had already taken place for ten years (*ibid*).

Within the programme ‘Transition towards Sustainable Development’, the North Frisian Woodlands were selected by the government as one of the nutrient management projects and therefore obtained permission to use broadcast surface spreading until 2008. The focus was at a regional level. Part of the research in the Frisian Woodlands focused on governance and monitoring issues at a regional level. The questions dealt with were: How regional networks could develop their own specific approach to achieve the government goals in emission reduction, and: How this could be monitored by the regions themselves (Bouma and Sonneveld, 2004:26). The first aim was to find a balance in environmental measures for air, water and soil. The second aim was to develop a monitoring device that can make the environmental aims effectively achieved by the stakeholders. Again the Minister of Agriculture, Nature Management and Food Quality made an exception for the farmers that were taking part in the scientific project. In 2006 this research project showed the same results: broadcast surface spreading has the same effects on the environment as shallow injection. ‘The results we find lead us to careful conclusions’, stated Hoogland, farmer and chairperson of the North Frisian Woodlands. ‘By feeding less protein and cutting of the grassland at a more mature stage, the cows produce less nitrogen in the manure, which has a positive effect’ (TransForum Agro and Groen; 2006:1).

6.5. The activities of VEL and VANLA to negotiate space in the law on excretion norms

After October 2003, the European Court of Justice, in a case brought against the Netherlands by the European Commission, ruled that the Dutch system of rules and regulations (in particular MINAS) did not guarantee an adequate or timely realization of the requirements of the EU Nitrate Directive. After this, the Dutch government had to apply the European excretion norms. Over the past few years there had been many contacts between the government in The Hague and the participants of the Nutrient Management Project, in which negotiations took place on changing the law on excretion in favour of innovative farmers that implement the trajectory of good manure.

Minister Veerman visited the Nutrient Management Project of VEL and VANLA in 2003. Members of the Standing Committee of the Ministry of LNV also spoke with farmers and scientists about the potential of the new trajectory in 2003. In the same year, during a meeting between the Minister and the Standing Committee, members of different parties (i.e. the Christian Democrats and the Socialist Party) emphasized that innovative farmers should be heard and that the trajectory in which animal manure is treated as a resource is highly relevant as the new manure policies force the farmers to see manure as a resource, instead of a waste product. The farmer needs to invest in improving the quality of manure (Anonymous, 2003b).

In 2003, the Minister proposed a new law on excretion. In this law he proposed to calculate the amounts of manure production on the basis of European legislation. However, he diversified the law by proposing that there was a lower excretion norm when one uses less protein and has a lower milk production per cow, and a higher excretion norm when one uses more protein and has a higher milk production per cow (Anonymous, 2003: 2). One year later he explained his decision in Parliament. He stated that he decided to introduce a new criterion, namely urea and he added that farmers in the Netherlands already make use of the possibilities given. (Anonymous, 2004a)

So, the minister decided to make a distinction between farmers who use less or more protein (urea is used as an indicator for that purpose) and farmers who have a lower or higher milk production per cow. In the following table this is explained.

Table 6.3. Variation in norms for excretion per cow

Urea	Milk production per cow	< 7000 litre/cow	7000-9000 litre/cow	>9000 litre/cow
<25		90 N/cow 2.6 cow/hectare		
25-35			114,6 N/cow 2.3 cow/hectare	
>35				140 N/cow 1.2 cow/hectare

Table 6.3. shows the variation in the norms for excretion per cow. Urea and milk production/cow are variables to estimate the excretion per cow. The indicator 'urea' is an indicator for the use of protein in the cow diets. Milk production per cow is an indicator of how intensive the farming system is. Farmers that use less protein in the diets of the cows and that have less milk production per cow are in an advanced position since they are allowed to have more cows per hectare.

Furthermore, in 2005 and 2006, the Minister introduced an exception to the law on excretion norms; which is called Manual Farm Specific Excretion (in Dutch: '*Handreiking bedrijfsspecifieke excretie*'). In this way, the farmers can calculate themselves the manure production and the amount of nitrogen and phosphorus in the manure. *Koeien en Kansen* developed a tool with which farmers in the Netherlands could make use of this exception to the laws, and were assigned to be responsible for the coordination of this regulation.

On the 24th of October 2006 secretary of state Van Geel handed over the first Frisian Woodlands certificates, based on this Manual Farm Specific Excretion, to some farmers from the Frisian Woodlands. This certificate was a symbolic proof that these farmers farmed according to the ways of the environmental cooperatives and reached the goals of the national government in their own ways.

6.6. The activities of VEL and VANLA to expand the carrying network

The narrators of good manure of the VEL and VANLA Nutrient Management Project aimed to introduce the storylines within a wider carrying network, both among the farm communities as well as scientific communities. The visions on manure quality, as developed within the Nutrient Management Project, were attempted to be made more robust. New experiments took place as well, showing similarities with the storylines developed within the Nutrient Management Project. The project called *Slim Experimenteren* (Smart Experimentation) is a follow-up of the many elements of good manure and the systems perspective thinking, with some alterations. The project called *Praktijklab* developed activities that were based on the use of the systems perspective, but the outcome was based on traditional views on innovation. The project of the North Frisian Woodlands, which took place in 2005 and 2006, was a continuation and enlargement of the Nutrient Management Project with new actors.

The findings of the research activities of the VEL and VANLA Nutrient Management Project resulted into a great variety of results. The Nutrient Management Project has resulted in various publications about the possible use of the systems perspective for joint learning and the use of the model for calculating nitrogen cycles in dairy farms (e.g. Stuiver *et al*., 2004b; Groot *et al*., 2003b). Research into soil characteristics and soil life has lead to various publications (e.g. Sonneveld and Bouma, 2003; Goede *et al*., 2003). Different societal debates took place in which the storylines of the VEL and VANLA Nutrient Management Project were brought forward. The issue of farmers' knowledge became object of debate in a project financed by Wageningen University. Different actors collectively shared their insights on the role of different modes of knowledge production in nutrient management (see chapter 7). There was public attention and media exposure of similar farms that made good manure (Van Zomeren, 2003; Van der Vlugt, 2001). The Manure Application Advice was criticized for not integrating farmers' knowledge and it became the topic of a research project (see chapter 7).

The farmers and scientists in the Nutrient Management Project presented their results within a network that also had its own experiments with understanding and developing nutrient management. There was already an emerging need within the agricultural sciences to study farming systems in a trans-disciplinary and holistic way (Anonymous 2000a). Researchers produced publications that dealt with nutrient management (Schröder *et al*., 2006; Schröder *et al*., 2007). Two books that serve as a guideline for the farmers to increase nutrient management (Nederpel *et al*., 2000; Van der Schans *et al*., 2001) and a books about soil management and soil life was published (Van Eekeren *et al*., 2003). At other nutrient management projects like *Koeien en Kansen*, the systems perspective was developed as well (e.g. Oenema and Aarts, 2005). *Koeien en Kansen* became responsible for the monitoring of the Manual Farm Specific Excretion.

As the systems perspective was developed in different nutrient management projects and by different researchers, inevitably the question of ownership and authenticity appeared. For instance, Verhoeven, the project leader of the Nutrient Management Project of VEL and VANLA, referred in a book published by PMOV to the similarities between the Manual Farm Specific Excretion and the soil-plant-animal system of the Nutrient Management Project of VEL and VANLA (Schiere and Janssens, 2007: 148). He argued that the basis of the calculation is the same as the systems perspective used in the Nutrient Management Project. 'The calculation model was developed in 1996 by Van Bruchem and me. Now 10 years later, it is officially accepted by the government.' In the book of PMOV (Schiere and Janssens, 2007: 36) it is also stated that the Manual Farm Specific Excretion is an effort of the farmers that developed the trajectory of good manure. Schröder commented that the systems perspective is not invented by the farmers of VEL and VANLA and that no one can claim to be the owner of the ideas: 'Systems thinking is not at all new in research after dairy farming in the Netherlands' (Schröder, personal communication, June 14, 2007).

Scientist Bouma presented the systems perspective in his speech for the academic community in Wageningen (Bouma, 2002). In this speech, he pleaded for the appreciation of stories and novelties and the need to use them in the development of new research projects on nutrient management. Secondly, he said that there was much similarity between farmers and scientists. Both can gain innovative capacity by trying things that seem impossible. Thirdly, he argued that through these positive examples it is possible to create good alternatives for the future (Bouma, 2002). Bouma aligned himself with the narrators of good manure. Both were convinced that knowledge, developed outside the scientific domain, was a good source of innovations. He was also one of the co-authors of a report of the WRR, in which the Nutrient Management Project of VEL and VANLA was taken as an example of a new niche for sustainable agriculture that needed government support (WRR, 2003: 110).

The storyline of good manure was reified into management options for farmers outside the Nutrient Management Project. External communication initially took place by the establishment of study groups in other environmental cooperatives and via excursions for farmers in the Netherlands. Some of the farmers of the Nutrient Management Project were trained to give lectures and lead study groups. The measures taken by the 60 farmers to reduce nitrogen loss were communicated to a wider public through several journals like *Boeren in Balans* (Verhoeven *et al*., 2002; Verhoeven *et al*., 2003a; Verhoeven *et al*., 2003b) and a manual (Koen *et al*., 2001). The distribution of these products was organized by the Farmers Organization LTO and PMOV. Teachers of agrarian schools in the North of the Netherlands were also given a course on the insights of the Nutrient Management Project. Furthermore a simplified manure application advice, a urea comparison programme and a ration calculation programme were developed, that serve as translations of the storyline of good manure. There has been a lot of media attention for the results of the Nutrient Management Project. There was a presentation of the project in the national news (September 2003). Moreover, many articles appeared in various newspapers about the case of VEL and VANLA (Anonymous 2003c; Anonymous 2003d; Anonymous 2003e) and similar farms, for instance of farmer Spruit (Van Zomeren, 2003; Van der Vlugt, 2001). The idiom of making good manure, the stories about the successes of farmers like Spruit (Van der Vlugt, 2001) became widespread within the farming communities.

Farmers of PMOV and VEL and VANLA got involved in the project called *Slim Experimenteren*, a follow-up of the activities of the Nutrient Management Project of VEL and VANLA with some alterations. The specific aim was to encourage innovative capacity of farmers and speed up a regime change (Wolleswinkel *et al*., 2004). In this project, the development of the stories of 33 dairy farmers and their strategies were the central point of departure. The new project continued on the basis of these farmers and a couple of practices were selected to experiment with. This selection process started during a workshop in 2003 and was done by the farmers and other stakeholders. Three promising innovations were selected for the research. The research was narrowed down to learning processes of farmers, scientists and policy-makers about stimulating system innovation, by taking away obstacles and develop ways to scale up the novel farming practices (Roep *et al*., 2007: 1). The farms of the PMOV members are described as non-conventional practices. Roep *et al.* (2007: 10) state that what characterizes these innovative dairy farmers is that they break with deep-rooted ideas and practices. These are known for standing in the way of renewal. They search their own ways and get confronted with ideas and norms from the outside. They are known to overcome these obstacles, but not all of them. If the dairy farming sector needs to change, research, policies, agro-industry and extension workers need to change as well.

In the course of time, the difference between PMOV and VEL and VANLA turned out to be that VEL and VANLA concentrated on scientific consolidation of the research that started in 1999. PMOV on the other hand, aimed to develop new research and insights and started to look for new hypotheses and the unexpected. This is described by Van der Ploeg in the following quote: 'There is a difference between the two projects: VEL and VANLA and PMOV. It reflects a tension between the need for renewal and the need for consolidation. Our work demands both. We have to consolidate and make the work of VEL and VANLA into a success, so that the research that we started will be finished in a solid way, with conclusions that are based on thorough research. We also need to experiment within PMOV with new methods and insights to make sure that novelties become known and get institutional support' (Van der Ploeg, 2002: 1).

One other example where the systems perspective was brought forward is the project called *Praktijklab*. In July 2002, this project was started (Kool, 2003). The project explored the idea of the Netherlands as a field laboratory, in which innovations take place. Its aim was to make a wider dissemination of innovations involving Nutrient Management possible. The project had three phases. The first phase was an inventory of practices in different areas of Dutch farming: arable farming, bulb farming, horticulture and dairy farming. The practices focused on the reduction of nitrate leaching and emission surpluses. The second phase was to test these innovations in a classic laboratory setting. The third phase was to disseminate the results over a wider public. One of their conclusions is interesting. They stated that in the dairy sector it becomes clear that the systems perspective is gaining in importance, apart from technical solutions only. However, their way of doing research was still based on a traditional way of testing innovations in laboratories and dissemination of the findings among potential users.

As mentioned in 6.5., the project called 'North Frisian Woodlands' took place in 2005 and 2006 and was a continuation of the Nutrient Management Project of VEL and VANLA. Furthermore a scientific project, *3MG*, started in 2006 and 2007, which studied the environmental targets for the North Frisian Woodlands. Some of the researchers (e.g. Sonneveld and Bouma) involved in the Nutrient Management Project of VEL and VANLA were engaged in the projects, but a larger network of scientists from all over the Netherlands was also included.

With these two projects, the farmers of VEL and VANLA became involved in a new network that financed and co-developed their nutrient management activities with them. For instance, the research questions were partly co-developed by representatives of TransForum. TransForum is a network that was formed to enhance sustainable agriculture in the Netherlands. In 2004, the Dutch Government decided to grant money by so-called BSIK finance to transition organizations such as TransForum. TransForum's general aim is to promote a more sustainable development of agri-business and green space. The knowledge they aim to mobilize has to be developed and researched by multiple stakeholders. Eventually, their aim is that the innovations produced also change the knowledge innovation system in the Netherlands. TransForum therefore collects good practices of various knowledge practices for sustainable development (Leeuwis *et al*., 2006).

By choosing to cooperate with TransForum, the Frisian farmers became part of a network in which different views on innovation and regime change are present. For example, the mission statement of TransForum is that it promotes diversity in the agricultural regime and knowledge infrastructure and does not have a preference of normative views on regime change. It does not claim to pursue a radical transition of agriculture, since it does not choose between radical or incremental innovations (TransForum 2007). Within the organization, a debate is going on, on how to deal with these different views on innovation and regime change. One of the project leaders for instance, mentioned that some of the members of the board of TransForum seem to be representatives of the current agricultural regime (Mager, 2007).

6.7. Conclusions

This chapter follows the narrators of the storyline of good manure and how they aimed to build a new niche where farmers' practices on good manure based on the systems perspective should be given more institutional room. Different types of activities were important for expanding the experiment of making good manure to the level of a niche: dissemination of information, the development of a network of actors and stakeholders, the involvement of competing parties in this network, the setting-up of partner experiments, and a modification of the regulatory and political framework, facilitating new or similar experiments (Weber *et al*., 1999: 50).

The narrators of good manure told their storylines in different settings, e.g. within the scientific and farmers' communities, in meetings between farmers and government officials and in court cases. The story they told needed different versions. Within the scientific communities, proof was gathered to make the claims accepted by scientists and government officials. Within the farming communities, the storyline of good manure was reified to management options that farmers could introduce in their practices.

The narrators argued that there should be more room for farmers that make good manure in the regulatory and political framework. These farmers should be allowed to achieve the sustainability demands with their own means. In the course of time, the story that there are several variations of good manure practices became more accepted. For example, in the law on excretion norms, these local variations are integrated. The storylines developed within VEL and VANLA became the trajectory for new research, i.e. the research projects performed at the farm of Spruit and in the Frisian Woodlands project.

Still, the body of knowledge that was constituted by the narrators of good manure did not result in a modification of the application policies. Within the scientific community the claims remained to be contested. The government decided that broadcast surface spreading was only allowed at scientific projects. It is still the question whether the Nutrient Management Project of VEL and VANLA gathered enough evidence and robust knowledge in the eyes of 'others' within the expanding network, to change the policies on manure application.

The storyline of good manure also interacted with simultaneously evolving projects on nutrient management. Within other nutrient management projects, the systems perspective was also explored and publications were produced. New initiatives emerged, in which farmers gathered and experimented with novelties on nutrient management that also aimed for a radical regime change (like PMOV). Other projects also took up the systems perspective and revised it for their own purposes (like the project called *Praktijklab*). The Nutrient Management Project of VEL and VANLA developed into two new projects, in which new members entered the network via the organization of TransForum. The question is, whether the ideas on regime change that the narrators of making good manure aimed to achieve, were still shared by the members of the carrying network. It is unclear whether new actors within the network adopt the views on innovations and regime change as formulated in the beginning by the narrators of good manure.

Stellingen

source Praktijkcijfers

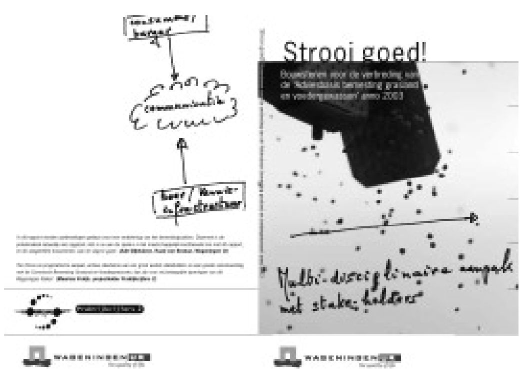
Rector Magnificus Professor Speelman receives the statements from projectleader Vrolijk in 2001

photo R. de Goede

Soil

photo R. de Goede

Worm



source Wageningen UR

Publication of the Wageningen project on the Manure Application Advice (2003)

7. Narrating good manure in scientific practices: two cases of Wageningen University and Research Centre

7.1. Introduction

The narrators of good manure also aimed to give way to other modes of knowledge production. In 2000 and 2002, there were two projects in which different actors who worked on manure practices met each other, to look at the possibilities of altering modes of knowledge production within the agricultural sciences. This chapter explains how the projects came into being and for what reasons the participants wanted to establish the projects. It investigates what these narrators wanted to change about the design and epistemology of the agricultural sciences. It looks at the perceptions of the actors, of how agricultural knowledge production should change in order to include other modes of knowledge production like farmers' practices and expertise on good manure. In section 7.2., the material and methods for this case are presented. In section 7.3., the first case is presented. This case is the 'Wageningen Working Group on Experiential Knowledge', a temporary network of scientists involved in nutrient management projects in the Netherlands. In section 7.4., the second case is presented: the 'Project on the Manure Application Advice'. Section 7.5. contains the conclusions of the chapter.

7.2. Material and methods

The first case study is based on my participation in the Wageningen Working Group on Experiential Knowledge. In 2000, a series of meetings took place under the supervision of the 'Wageningen Working Group on Experiential Knowledge'. The main question for the Working Group was: how to design a research process in which farmers' expertise is included? The project team consisted of a variety of people. Three project leaders that worked with farmers in the nutrient management projects VEL and VANLA, *Bioveem* and *Koeien en Kansen* were present; Verhoeven, Baars and Galama. Scientist Spoelstra was present as an external advisor and scientist Proost facilitated the meetings. My role in the Working Group on experiential knowledge was to assist in the facilitation of the meetings. I analysed the meetings to determine the variety of opinions on the research design of the various nutrient management projects.[xxxviii]

The case study is based on two meetings which I attended. The first meeting was a conference organized by the Working Group. This meeting was used to describe the perception of the actors on farmers' knowledge and their views on how agricultural sciences should change to encourage knowledge development by different actors beyond the boundaries of the academia. The second meeting was a Working Group meeting at which project leaders Verhoeven, Baars and Galama discussed the role of farmers' knowledge in the different nutrient management projects. This meeting was used to understand the different insights within the nutrient management projects on how farmers' knowledge should be integrated in the research process.

The second case study is based on my participation in the 'Project on the Manure Application Advice'. This project was established thanks to a group of dairy farmers of *Praktijkcijfers* that articulated criticism on the existing manure application advice. The farmers explained their criticism to the board of directors of the Wageningen University. A meeting followed, at which it became clear their criticism was recognized within the scientific community. It was decided that a project should deal with these issues. The challenge for this project was twofold. The first challenge was to make an overview of the problems that different users of the Manure Application Advice encountered and the solutions that they proposed. The second challenge was to synthesize the new demands for the future that needed to be integrated in the design of the Manure Application Advice. A project group was formed that was composed of scientists that were involved in the formulation of the Manure Application Advice. The members were Schils, who worked at the Animal Sciences Group of Wageningen University and was a member of the Committee of the Manure Application Advice, Van der Schans, who worked for the *Centrum voor Landbouw en Milieu* (CLM Research and Advice, hereafter referred to as CLM), a consultancy that specializes in the integration of environmental issues in the agri-food sector, Van der Meer, who worked for Plant Research International (PRI) and was also involved in the Committee of the Manure Application Advice and finally Vellinga, who worked for *Dienst Landelijk Gebied* (Government Service for Land and Water Use hereafter referred to as DLG) and who was provider of the scientific building blocks of the Manure Application Advice before that.

My role was to carry out the project in two phases, together with scientist Groot. The methods used during the first phase included mind-mapping to explore opinions and positions of the various stakeholders in the debate: interviews with eight farmers with a well-articulated vision on nutrient management, and a first workshop with extension workers and farmers. The second phase consisted of interviews with policy-makers and scientists with knowledge of new functions of the rural area and a second workshop with a group of stakeholders that were involved in the Manure Application Advice and the new demands needed for a new Manure Application Advice (Groot *et al*., 2003a). Various interest groups were involved: farmers, environment and nature conservation organizations, national and local governments, industries, extension workers and researchers. Because of my involvement as a facilitator and researcher I got a good overview of the different views and opinions of the participants.

7.3. The 'Wageningen Working Group on Experiential Knowledge'

'When will you scientists start to take seriously what we farmers know about manure practices?'

Wageningen University and Research Centre organized a workshop in November 2000 to improve alignment between the various researchers and project leaders of nutrient management projects. The workshop was called 'System approaches in agriculture for further Nitrate Reduction'. Participants of different nutrient management projects, *Koeien en Kansen*, VEL and VANLA, *Bioveem* and *Praktijkcijfers* met each other. They discussed insights and experiences on nitrate reduction with the challenge to understand more of the system approach.

The quote above was from Atsma, chairperson of the environmental cooperative VANLA. He gave a speech on the relevance of farmers' knowledge within the Nutrient Management Project of VEL and VANLA. He asked the other project leaders of the various nutrient management projects which role farmers' knowledge played in their activities. During the workshop it became apparent that farmers' knowledge was valued differently within the several research designs. The participants at the workshop expressed the necessity to further explore the role of farmers' knowledge and the implication for research design.

For this purpose, a series of meetings took place in 2001 and 2002, under the supervision of the 'Wageningen Working Group on Experiential Knowledge'. The main question for the Working Group was; how to design a research process in which farmers' expertise is included? The first meeting was a conference organized by the Working Group. The second meeting was a Working Group meeting at which Baars, Verhoeven and Galama discussed the role of farmers' knowledge in the different nutrient management projects.

Meeting 1: The conference on experiential knowledge

During the conference on experiential knowledge held in March 2002, a group of 30 participants discussed the question whether farmers' knowledge was relevant and if so, how to give way to it within the agricultural sciences. The participants involved were farmers of various nutrient management projects, scientists of Wageningen University, consultants of farmers' organizations and some scientists of other fields of research. The aim of the day was to exchange knowledge concerning the topic of experiential knowledge among scientists and to find guidelines for the translation of the new insights into research practice of the agricultural sciences.

During the introduction, the main message of the conference was formulated: farmers' knowledge matters. Niels Röling, who used to be Professor of Agricultural Knowledge Systems in developing countries in Wageningen, gave a presentation of the role of farmers' knowledge in developing countries, by giving examples of the importance of it, based on his own experiences (Röling, 1996; Röling; 1988; Leeuwis and Pyburn, 2002). He pleaded for an integration of farmers' knowledge in the agricultural sciences. An expert in medical sciences gave a speech on the role of experiential knowledge in the diagnosis of patients and stated that within the field of medical science, experiences (both of patients and doctors) are getting more important as well. In health care, with all its complexity, working with experiential knowledge is a basis for all actions. Since none of the participants seemed to disagree with the statement that farmers' knowledge matters, the discussion rapidly moved on to the following question: How to give way to it within the agricultural sciences.

Atsma, the chairperson of the VANLA cooperative, stated in his introduction: 'Innovations are developed in the field, but we are not given free rein to develop them.' With his statement, he aimed to convince others at this meeting that farmer's innovations are important sources of knowledge for the agricultural sciences. In his introduction, he explicitly used the word 'we'. When I asked him afterwards why he used this word, he said: 'We, that is us, the farmers, but also the people who believe that the soil-plant-animal system works, people that are working on the alternative route to manure, in practice and in science.' I also asked him who should give him free rein. He answered: 'Well, I have asked myself this question for such a long time. It started with the agricultural organizations that were afraid to be innovative in nature and landscape issues. But also the Ministry of LNV is a black-box of legal advisors, who want security and do not understand our farming practices. So we need to know what to give them; concrete actions, that they can control, monitor and measure.' His strategic message in this quote is clear: in order to develop innovations in the field, scientists have the task to make other arenas like the government more responsive to farmers' innovations. This implies changes within the academia. Atsma also described the tasks for the scientists involved: speak the language of the farmers and together with the farmers, develop concrete instruments that others can accept.

Verhoeven, the project leader of VEL and VANLA, gave a workshop with the same question in mind: how to give way to farmers' knowledge within the academia. During the introduction of the participants of the workshop, they all expressed to work with farmers, either as scientists or as extension workers. They were interested in the changes that are needed in the agricultural sciences. Verhoeven presented VEL and VANLA as spaces in which new areas of knowledge are discovered, as well as new modes of knowledge are experimented with. During his workshop he criticized the agricultural sciences for not being adapted to the new needs of innovative farmers. Not only should the agricultural sciences change their design of knowledge production, they also should change their epistemologies. This change should imply that the focus is not only on the development of knowledge in the laboratories and experimental farms, but also on the exchange between farmers and the active discovery of farmers' knowledge. In his presentation, he gave the example of the systems perspective as an alternative epistemology for the agricultural sciences.

One participant stated that, in his opinion, it has already become more important to communicate under which circumstances farmers have performed their experimentation. He said: 'When a farmer experiments with things, it fits in with the locality of the farm. When others want to know what farmers do, you have to know exactly what they did and under which circumstances the experiment took place.' One other participant added that the same happens with laboratory experiments.
The circumstances within the laboratory also influence the outcomes of the research. The two participants agreed: when farmers' knowledge and scientific knowledge meet within experiments, one should not only communicate the blueprint, but also the processes and circumstances of knowledge production. A third participant added the example of protein-poor feeding, as experimented with in

the Nutrient Management Project of VEL and VANLA. She stated: ‘This is an example of a search, not a blueprint.’

One participant mentioned that it seemed to be getting more important for farmers to develop their own know-how again and start to look at the specific localities of their farms. As an example, Verhoeven told about the farmer of VEL and VANLA who looked for a manure application machine that could be used at the parcels between the hedges and belts of elder trees. Via his son, who did an internship in the North of Germany, they found a machine that could apply manure on these small parcels. They took the machine to Achtkarspelen and adjusted it further to the Frisian Woodlands, so that it could be used by the farmers in that area. This started the discussion about the question of how to find innovations. One may find localized innovations in specific geographical and physical circumstances, for example small-scale landscapes or other marginal areas. Another participant gave another example: ‘Our work in Burkina and Niger shows that farmers create their own solutions that can be useful to others as well. Farmers from Niger have visited farmers in Burkina to understand the methods for land rehabilitation. In Niger the farmers experimented with the methods from Burkina and they were so successful that they now sell fertile land to generate money and buy infertile land, because they have methods for land rehabilitation.’

The participants concluded that new networks among farmers could stimulate this circulation of knowledge. One example is PMOV, which started on the initiative of Van Bruchem, who combined research of the APM with the experiences of the farmers of VEL and VANLA (Schiere and Janssens, 2007). PMOV was regarded by the participants as an alternative to the already existing networks subsidized by the government, the so-called ‘nitrate projects’ (see chapter 3). PMOV provided an alternative in two ways; first of all it developed innovations that were often controversial and not always considered to be robust by the outside world; secondly it developed alternative methods of doing research, with the focus on the experiences of the farmers.

The discussion continued about the right methods to do research. Could the alternative methods of PMOV have a future in the agricultural sciences? The first assumption that should be negated, according to the participants of the workshop, was that knowledge is only true when it is universally applicable. The participants discussed why agricultural scientists find it hard to drop this assumption. One participant commented: ‘So often, when scientists ask themselves a question about food and nutrition, the standard approach is to take a couple of cows and test it in a laboratory. These ways of thinking and routines are still embedded in the ways of thinking of many scientists.’

Which skills are needed for scientists to incorporate farmers’ knowledge in research? One participant summarized his main recommendation. ‘Since you need crazy farmers, you also need crazy scientists. If you cannot publish it, well then start a magazine or journal yourself. Dare to innovate in the academia yourself.’ Farmers’ knowledge can be incorporated during different phases of research:

while establishing the aims and hypotheses of the research, during the experiments and data-gathering, during the analysis and translation of these data in texts or brochures, and during the dissemination of the research. During their work the researchers and farmers should view each other's knowledge and expertise critically. Both groups have to be aware that they are in different positions and come from different localities. One participant said: 'Never try to have the same knowledge but stay open-minded to each other's contextualization of knowledge, communicate about the context of a farm or the research setting. A good scientist accepts that he is a boundary worker[xxxix]: he is open to other people's languages, able to reflect upon epistemology, not afraid of confrontations and so on.' One participant added to the discussion that it is important that scientists can secure a certain status from research that is relevant to society. The status of scientists should not only be based on publications in established peer-reviewed journals. Other scientific products should be valued equally, such as the participation in societal organizations, the development of on-farm innovations, or publications in magazines and journals outside the scientific community. In this way, the scientists' accountability towards society can be enhanced.

The conclusion of the conference was that a lot of networking and lobbying will still be needed to put experiential knowledge on the agenda. The value of farmers' knowledge was clear for the participants. However, in the agricultural sciences, the old routines of viewing science and experiments were said to be superior to other modes of knowledge production. So, the introduction of farmers' knowledge might be expected to meet opposition of various origins. Taking farmers' knowledge and experiences into account in research, means looking for much more complexity in doing research. Researchers will also have to shake off part of their roles as technical experts; they are not the only experts and other expertise needs to be acquired, like setting up and guiding interactive research and becoming boundary workers between science and practice. Furthermore the workshop concluded that it is important to be explicit about the choices you make in a research project. Therefore different elements of the research process should also become object of debate. The first element is the research philosophy: what are the epistemology and the values that are formulated? The second element is the formulation of research goals: who benefits from the research? The third element is the research process: who controls the formulation of hypotheses, the gathering and analyses of data and the formulation of conclusions?

Meeting 2: The working group on Experiential Knowledge

During this second meeting of the Working Group on Experiential Knowledge, three members of the Working Group presented their nutrient management projects. The main discussants at this meeting were Verhoeven, project leader of The Nutrient Management Project of VEL and VANLA, Baars, involved in *Bioveem* and Galama, project leader of *Koeien en Kansen*. The aim of their discussion was to answer the following question: what is the role of farmers' knowledge in the research design of these projects? Below the three projects are described, from the perspective of the research design of the projects and the views on innovation involved. First of all I present a brief description of the three projects. Then I give an analysis of the meeting between the three project leaders.

Koeien en Kansen

Koeien en Kansen is a project financed by the Dutch Ministry of LNV. It started in 1999 and lasted until 2006. It served as a national scientific project to monitor the consequences of the national goals on nitrate leaching and ammonia volatilization. Two aims were formulated: the first aim was doing research and the second aim was demonstrating the results to other farmers. The 16 dairy farmers involved participated in study groups and set up regional study groups. Seven farms, together with the experimental station *de Marke*, were the locations where experimental research took place, with intensive scientific monitoring. This scientific monitoring implied the possibility of finding a scientific indicator for, for instance, soil quality. Manure application technologies were researched as well. The other nine farms focused on knowledge dissemination via the set-up of regional networks or study groups. Most of all, they had a communicative function, to spread the innovations to a wider group of farmers. In this way, the information was supposed to spread over a large group of farmers.

The research design of *Koeien en Kansen* was based on a direct relation between research and practice. Seven farms were linked to the experimental farm. Through scientific research, these innovators were supported when they faced challenges or found questions they could not answer themselves. Galama commented: 'The role of experiential knowledge of farmers? The seven farmers are very good at asking questions on what to investigate within the projects. We can use their knowledge on what will be easy or difficult to achieve. The nine farmers who implement the measures are also involved in the discovery of critical factors of success at the farms.'

VEL and VANLA

The Nutrient Management Project of VEL and VANLA developed a set of innovations in dairy practices that have been labelled as developing good manure from a systems perspective (see chapter 4). Their aim was to reach enough understanding about the feasibility and robustness of this (in their opinion) alternative technological trajectory in comparison to the dominant regime. Therefore the Nutrient Management Project developed both practical and scientific knowledge on sustainable dairy farming systems that would be applicable in a small-scale multi-functional environment. They also actively informed dairy farmers that were in a similar situation about the possibilities developed during the project, so that others could benefit from the knowledge as well.

To achieve their aims, the 60 farmers and the 30 researchers participated in a web of research projects. They had a research council and study groups in which the participants actively exchanged their experiences and expertise regarding the hypotheses formulated. The farmers were divided into three groups that all participated in study groups. VEL and VANLA had close links with the APM where the systems perspective was also tested in practice. The farms of VEL and VANLA were considered to be experimental farms because all 60 farmers developed their own ways of experimentation and were monitored closely in their data. At two farms, Hoeksma's and Sikkema's farm, research on location took place into grassland management and ammonia volatilization.

The Nutrient Management Project of VEL and VANLA started with the formulation of the farmers' experiences. This should be the basis of the novelties that were to be discovered. Together with the scientists, the farmers experimented with knowledge production. On that basis of interaction with researchers, the exploration of the systems perspective became crucial (see chapter 4). The measures to investigate the systems perspective at farm level were used as adaptations within the farming systems. The measures were not used as blueprints; they were recommendations for on-farm trials. The degree and the way in which these measures were useful were different for each farm. The experimentation with these measures resulted in 60 farms with various measures, goals and experiences.

Bioveem

The general goals of *Bioveem* were to enhance innovations and knowledge creation for the organic dairy sector in the Netherlands. The project aimed to enhance participative knowledge development between farmers and researchers. *Bioveem* aimed to upgrade already existing innovations present at farm level. They did this by making a distinction between three groups of farmers and giving these three groups different support in knowledge development.

The first group were called the pioneers; dairy farmers that have already committed themselves to organic farming for a long time. According to the project, they were the pioneers, have shown to dare to take risks and had many questions to solve. These farmers were the ones who chose the themes and defined their aims for the coming time. These farmers got support from the researchers in their experiments. The results could serve as starting points for further exploration and research at the farms of the second group. The second group consisted of organic dairy farmers who were receptive to organic farming and were willing to generate knowledge together with the pioneers and learn from them. This group set clear aims on the basis of the insights of the first group and wanted to achieve these aims during the project. Researchers monitored their steps and built bridges between knowledge of these farmers and knowledge of other sources. The final group was composed of dairy farmers that had chosen to convert to organic farming. They got personal assistance in learning new skills. They participated in study groups with organic farmers from the second and first group. In this way, the knowledge from the first and second group got spread over a larger group of dairy farmers in the Netherlands. No research was taken place among the farms in this group. Baars formulated the philosophy of *Bioveem* in this way: 'Most researchers are used to give technical solutions to problems that farmers encounter. The risk is that the focus is on part of the system and not on the system as a whole. Instead, we take a look at the things that make the farmer enthusiastic for his farm and what he is challenged to do. We investigate the innovative solutions of farmers, because that leads to renewal'

During the meeting, a discussion was started about various topics that involved knowledge production in the three nutrient management projects. Verhoeven, Galama and Baars agreed that doing research is an interactive process between the involved stakeholders. But, the ways this was translated in the research design of the three nutrient management projects was something that had to be explored and compared.

The first topic was about the formulation of the research questions. Verhoeven explained that during the formulation of the research questions of the Nutrient Management Project of VEL and VANLA, there was a dialogue between the participants. Verhoeven and the other scientists always wanted to take the questions and research options of the farmers very seriously. Through intensive discussions with the 60 farmers in study meetings, their questions became a starting point in the research design. Some of the 60 farmers were considered to be more experienced as innovators, and their knowledge and expertise were extensively discussed in the research council (see chapter 4). Galama stated that *Koeien en Kansen* had another approach. The scientists formulated research questions in order to reach the national norms for nitrate reduction. Furthermore, the farmers who were part of the experimental farm group could ask for scientific research if they needed it to test their experiences. Baars explained that *Bioveem* started with the questions and experiments of the farmers that were considered pioneers. The research of *Bioveem* was based on the view that farmers could contribute to scientific solutions by providing experiential hypotheses, experimenting at the farms and monitoring the outcomes together with scientists. Important elements of experiential science were personal involvement, pattern recognition and intuitive acting (Baars and De Vries, 1999). Baars' work in the *Bioveem* project had convinced him that all relevant actors (researchers, farmers, DLV consultants, representatives from the animal feed industry and veterinarians) could learn what is important and what is not important in nutrient management projects, through experiential knowledge. During the discussion, Baars stated that the formulation of the research questions seemed to depend strongly on the dominant epistemology of the actors involved: 'When farmers' knowledge is involved in the design, it should not make a difference for the design, since the farmers can also reason from the same epistemology as the scientific point of view.' Verhoeven and Galama agreed with this. Farmers (as well as scientists) were not a homogeneous group and their views on knowledge and truth were differential. So the definition of the research questions was mainly a matter of the persons that meet, their epistemologies and the dynamics between them. This was often hard to organize and could not be planned precisely and was experienced to be a contingent process.

The second topic was about the models of innovation on which the project was based. *Bioveem* and *Koeien en Kansen* had a clear view on what to do with the knowledge that was developed during the experiments. Based upon diffusion of innovation models, they divided farmers into categories of innovators, early adopters and laggards (Rogers, 1962). They based their communication of the results on these three categories. When the implemented measures of the innovators were successful, they were presented to other farmers as possible solutions for their farming practice. The model of 'diffusion of innovation' was considered the most efficient form of knowledge transfer within the dairy sector (see also chapter 3). The difference between *Bioveem* and *Koeien en Kansen* was that the first project aimed to achieve more organic farming as a niche in Dutch agriculture, while the second aimed to change dairy farming to the norms set by the national government. VEL and VANLA had a different view on innovation. As a result of the involvement of scientists dealing with Strategic Niche Management, they took the position that a radical regime change is needed, where the farmers in their experiments were the starting point for providing innovations. The regime should change in favour of the farmers that make good manure. Policies and knowledge infrastructure should adapt according to this storyline. Verhoeven explained how he worked: 'In science we know to the extreme what can happen, but still we ask the farmers to find their own boundaries, therefore they have to know their own locality and experiment with their own local versions.'

The third topic was about the epistemologies the three projects communicated to the outside world and whether these were in line with the epistemologies that sustained the research activities within the projects. *Bioveem* and VEL and VANLA embraced farmers' knowledge in their presentation to the outside world and used the systems perspective to integrate different types of knowledge from different backgrounds to arrive at conclusions. The research council and study meetings of VEL and VANLA were given as an example to guarantee the involvement of farmers throughout the research process. In *Bioveem* as well as *Koeien en Kansen*, there were also frequent meetings in study groups of farmers and scientists. *Koeien en Kansen* also reported about the necessity of the systems perspective to the outside world. One example is a publication from *de Marke* that introduced the systems perspective as a means to overcome the crisis in the manure regime (see Aarts *et al*., 1988; Korevaar *et al*., 1988). Still, the project leaders agreed that researchers associated in the nutrient management projects often still organized their scientific research on the basis of classical experiments in research stations and laboratories. During the research procedures, the scientists involved were often acting as experts in their specific field and they did not look for the cooperation with farmers. All three project leaders agreed that experimenting with the involvement of farmers' knowledge in the research process was often a complicated matter and scientists did not have the relevant knowledge of it. In that sense, the research projects still could improve in the future.

7.4. The 'Project on the Manure Application Advice'

The Manure Application Advice was established by the Dutch government after the Second World War, to implement a set of methods for applying chemical fertilizer in the form of nitrogen to increase grassland production. The Manure Application Advice was based on various experiments that were done on test plots by several researchers in the period of 1934-1975 (see De Wieling *et al.*, 1977). Since its establishment, the Manure Application Advice has been altered several times. Initially, the Manure Application Advice referred to the maximum annual nitrogen application and the way in which this amount of nitrogen should be divided over the seasons and the cuttings of the grassland. The Manure Application Advice was implemented by many dairy farmers. Many of them applied the maximum dose of 400 kg N per ha per year.

After 1980, forced by the environmental lobby, a debate on the reduction of fertilizer use took place. Three positions were found in the debate (Noij, 1989). The first position was to avoid excessive use of fertilizer by the strict implementation of the Manure Application Advice. The assumption was that when the Manure Application Advice would be implemented there would no problem for the environment. The second was to adjust the Manure Application Advice to types of grassland, soil type and surface water. These measures should result in a decrease of unnecessary nitrogen use at the farms. The final position was that environmental measures are more important than farm economics; it does not matter if the profits of the farms decrease as long as the environmental effects are reached.

The Manure Application Advice was adjusted to types of grassland, soil type and surface water. These measures should result in a decrease of unnecessary nitrogen use at the farms. The new Manure Application Advice in 1993 showed a considerable expansion of the earlier versions and became a new publication for education, extension and the industries (Agterberg *et al.*, 1993).[xl] The recommendations of the Committee on 'Nitrate' (in Dutch: *Commissie Stikstof*) (Goossensen and Meeuwissen 1990) and the advice of the Dutch Advisory Council of the Environment (in Dutch: *Centrale Raad voor de Milieuhygiène*) in 1991 to relate manure application to environment aims, were not transcribed into the Manure Application Advice (Hanegraaf and Middelkoop 1998). This was acknowledged by Agterberg *et al.* (1993). This book also pointed out that in order to meet the environmental demands a separate advice seemed to be needed, because of the discrepancy between economic gains and environmental aims.

These recommendations are used in a new Manure Application Advice in 1998 (Commissie Bemesting Grasland en Voedergewassen, 1998), in which distinctions are made between various types of soil, grass production levels and the number of cutting stages. The Manure Application Advice of 1998 gave recommendations on how to stick to the MINAS norms and reduce nitrate leaching after the growth season. Furthermore, a Nitrate Leaching Reduction Planner was introduced that calculates the effects of the farmer's management on the amount of nitrate in the soil in autumn. (Commissie Bemesting Grasland en Voedergewassen 1998; Vellinga *et al.*, 2001).

In the beginning of 2002, several actors started to criticize the Manure Application Advice. Dairy farmers within the project *Praktijkcijfers* II (2000–2002) expressed several management problems while working with the Manure Application Advice. On the 29th November of 2001, they left a number of statements about the Manure Application Advice at the front door of Wageningen University and Research Centre. *Rector Magnificus* Professor Speelman received the statements. During a meeting that followed, scientists and farmers from the Nutrient Management Project of VEL and VANLA participated and stated that, in their views, the Manure Application Advice lacked to combine production goals with sustainability goals (Groot *et al*., 2003a). Others at this meeting did not agree and argued that the Manure Application Advice did aim to integrate sustainability goals. In their opinion the problem was that farmers did not follow the guidelines of the Manure Application Advice.

Professor Speelman proposed to make this debate into a project with two main challenges. The first was to make a list of the problems that various users of the Manure Application Advice encountered and the solutions that they proposed. The second was to synthesize the new demands for the future that needed to be integrated in the design of the Manure Application Advice. Two workshops were held during the Project. The first workshop in January 2003 had to formulate the shortcomings of the present Manure Application Advice. The second workshop in June 2003 had to formulate new recommendations to incorporate sustainability demands into the Manure Application Advice.

Workshop 1: The shortcomings of the Manure Application Advice

During the first workshop there were farmers with articulated knowledge and opinions on the Manure Application Advice because of their participation in nutrient management projects throughout the country. There were also scientists that were involved in the setting up of the Manure Application Advice as well as representatives of consultancies and fertilizer manufacturers that worked with the Manure Application Advice. The first workshop focused on the various problems that the participants experienced with the Manure Application Advice. In the following the discussion is presented, with a selection of the arguments stated by the participants.

The first problem that was encountered was that the Manure Application Advice, at the time of the workshop, lacked the renewed insights and farmers' knowledge on manure application. The Manure Application Advice should take over the hunches and hypotheses of farmers and perform research into it. In the discussion it was agreed upon that scientific research needed to be the basis of the Manure Application Advice. The participants looked at the interaction between farmers' knowledge and science in various ways.

Farmer Houtstra: 'What I am interested in: if you talk with farmers about soil life, it is all very vague. For science there are opportunities to make it more concrete. For example, it makes a difference if you have 1 or 5 million worms in your soil.'

Houtstra stated that farmers' knowledge and impressions alone are too vague in his opinion. He was not convinced that these ideas could become concrete enough, to be translated into the Manure Application Advice. In his opinion, science and scientific procedures provided knowledge that was more robust. Farmer Diekstra agreed with him, but also stated that scientific knowledge should be generated in a different way than it used to, as exemplified in the following statement.

Farmer Diekstra: 'Then, the researchers need to learn to listen to the farmers and look at what has gone wrong in the Manure Application Advice until now, and what the reasons are.'

So, Diekstra stated that farmers have an important role in the evaluation of the validity of scientific knowledge. The Manure Application Advice could be a good reason to experiment with this type of knowledge production, because it already had shown that mistakes were made and that the end-users did not agree with the truth claims expressed in it. The following quote shows that interaction between scientists and farmers should be stimulated in his opinion.

Farmer Diekstra: 'Scientists keep saying that the advice is good and optimal. When you distance yourself from the opinions of the farmers like that, nobody will use it and you will never reach your targets. One example is the quality of the soil and the quality of the manure: so many people have said that it should be included.'

The above-mentioned statements also illustrate the second problem the Manure Application Advice is faced with. The participants at the workshop asked for new fields of research. Soil and manure were considered to be new topics of research. Farmers stated that they needed knowledge about processes in manure and soil that they could influence and that farmers can provide research questions that the Committee could pick up, to improve the Manure Application Advice. Therefore they also needed the new research to develop indicators that can help monitor and steer the farmers in management choices.

During the workshop, there were various opinions on whether the subject of soil had already entered the stage as scientific object of research. Farmer Diekstra stated that he had not noticed yet that research institutes and nutrient management projects were interested in the soil: 'The soil is still not a general object of research. We were at an experimental station with a working group. There we were asked to develop new themes around manure. We said: Do you want to look at mineralization and the soil? No, they said, the soil is not important for us.' The representative of a leading fertilizer manufacturer in the Netherlands, Troost, did not agree with this statement. He knew about projects in the organic farming sector that dealt with soil as an object of study. Scientist Schils had a different opinion as well. He mentioned the Nutrient Management Project of VEL and VANLA as a good example of a research project that studied soil fertility, but he also said that it could take some time before they present any findings and that the farming community should wait for these results.

A discussion started, on new indicators for the soil that are needed to improve the Manure Application Advice. During the discussion, the farmers and scientists agreed that mineralization is an important field of study and that the present indicator, the Nitrogen Delivery Capacity (NLV) was limited, with its maximum of 200. Farmer Diekstra stated: 'Yes, we need more parameters for the mineralization that can be translated into the Manure Application Advice.' Scientist Schils stated that NLV was a limited indicator for mineralization: I agree that mineralization can be different each year. It is an average that is calculated every 4 years. When the average is 180 kg, it is not strange that one year it is 100 and the other year it is 300. I agree that we need to get a grip on this diversity'.

This quote shows the third problem of the Manure Application Advice; the difficulty with averages and exceptions. One farmer gave an example of the average outcomes of soil and manure tests that he received from the laboratory. When the outcomes were tested several times, different outcomes were found. Troost had heard a strange story. Someone had told him that he had sent manure to nine laboratories to test the contents and that he had received nine different analyses. Whether it was true or not, the participants agreed that the averages often made no sense, because the outcomes vary per season, among other things. Scientist Schils stated: 'Manure varies throughout the year. No manure is the same, manure in spring, manure in summer. Therefore you should not work with averages.'

The discussion continued with the implications for the Manure Application Advice. Schils proposed that the Manure Application Advice would work with a certain range of extremes in which the actual situation can be fitted in. One of the participants added that it would be better if the Manure Application Advice would be a simple advice that can easily be adapted to different situations. This referred to the dilemma that science can provide the averages but that others need to deal with the local exceptions. Scientist Schils: 'The Manure Application Advice could be the basis that could be adjusted to your own specific situation. When you know specific details about your soil, you can fit it in the programme.' Troost mentioned as an example that the fertilizer company he worked for already had acknowledged this problem and changed the Manure Application Advice they used for their customers. They made an extra option in the advice, in which the farmer can fill in his own measurements. For arable farming they had done the same and they had developed a programme that takes into account C/N ratio, humus etc.

Changing the Manure Application in such a way would imply however that farmers need to develop a different attitude towards the use of scientific knowledge and the translation of it to their localities, based on their own local expertise. Farmer Houtstra stated that, in his opinion, the farmer is then forced to obtain knowledge on local processes and translate it to his parcels. The Manure Application Advice is no longer a simple advice to follow. His warning: 'The farmers are expected to perform a difficult task.'

Workshop 2: Ways of knowledge production needed for the Manure Application Advice

During the second workshop, farmers were present, as well as scientists from Wageningen University, representatives of the Dutch Farmers Organization LTO and two consultants of environmental organizations. The discussions focused on the best ways of knowledge production, as the basis of the Manure Application Advice.

A proposal was made to provide packages of knowledge that can support farmers in their management decisions. Some of the participants stated that farmers do not need standard advice, but that they need to understand more of their local circumstances. Examples were mineralization, soil processes, weather conditions and manure quality. Others were sceptical about the effect this knowledge would have on management decisions. In the following this discussion is reflected:

Scientist Verhoeven: 'The influence of weather conditions on mineralization is an example of an issue farmers have a great deal of questions about.'

Consultant Wiegers: 'You cannot use simple rules, you cannot deny the complexity of the matter. And what should a farmer do with this knowledge; can he or she change it into management options or not, that is important.'

Consultant de Rijk referred to what she considered to be a necessary change in attitude regarding the bodies of knowledge to send to the farmers. She stated: 'The knowledge needed is not the same as advice. It helps the farmers who need to make a decision. In other words, there is a difference between using the Manure Application Advice as a strict guideline for action, and using it as a set of stories and information and let the farmer decide what to do with it.' This would imply that farmers also should change their expectations of the type of information they receive.

A number of participants had strong arguments to put more emphasis on farmers' knowledge to influence the design of the Manure Application Advice. Other participants said that the discussion should be among experts. In their opinion, these experts could be farmers or scientists. Scientists need to prove themselves as experts by their work in the academia. Farmers need to prove themselves as experts by showing that they are able to fulfil the criteria set by the government. The following quote exemplifies how consultant Wiegers viewed the farmers within VEL and VANLA. In his opinion, the members of VEL and VANLA had shown to be experts because they had met the national government's standards faster than other farmers in the Netherlands: 'VEL and VANLA are getting experts in ammonia. Their study groups could add something valuable to the Manure Application Advice. Other groups look at water quality or soil quality. Pilot groups could contribute and regional specializations could be made as well. This way you get a better view of the role of the Manure Application Advice in the totality of the farm and its surroundings.'

In this quote, Wiegers proposed to invest in regional networks without necessarily mainstreaming them in the present structures. The innovative capacity of these local groups should be enhanced and be used to improve the general guidelines of the Manure Application Advice. Moreover, there could be regional groups that develop versions of the Manure Application Advice and integrate these with other sustainability goals. Special attention should be paid to groups that have been formed on an informal basis. 'For example, the local study groups of PMOV are formed spontaneously and can therefore be very interesting in their approach and might even have hidden and possible innovations.'

7.5. Conclusions

Two case studies were presented, in which actors that develop manure practices came together to explore the question 'what is valid knowledge' in nutrient management and what this would mean for the design of research projects within the agricultural sciences and the development of advisory schemes like the Manure Application Advice. Both projects are examples of research experiments within the agricultural sciences. Both projects involve actors from different backgrounds (research projects, farms, firms, scientists, consultancies) that share varied opinions and experiences.

Within the 'Wageningen Working Group on Experiential Knowledge', the actors who were involved from the beginning all agreed that farmers' knowledge really mattered. They all agreed that it was necessary to integrate farmers' knowledge into research projects. The participants stated that research projects should take up farmers' knowledge and actively focus on the development of farmers' innovations regarding good manure. They stated that farmers know things sometimes even better than scientists. They were strongly in favour of extending knowledge production beyond the scientific domain. In their opinion, advice schemes should also enhance farmers' expertise in their own localities. They stated that more emphasis should be put on the exchange and circulation of different sources of knowledge. The dominant epistemologies within research project should value this knowledge as equal to knowledge originating from laboratories and experimental settings.

The 'Project of the Manure Application Advice' showed a variety of opinions regarding the question 'what is valid knowledge'. The actors agreed on the fact that farmers should have more influence on the formulation of the Manure Application Advice, for instance by generating new subjects of research (like manure and soil) and by commenting on the applicability of the Manure Application Advice in view of management decisions. Furthermore, the actors identified gaps in the indicators used for management decisions, which should be used by science to explore new fields of research. The actors wanted more diversity in the contents and shapes of the Manure Application Advice. They proposed to nourish or even actively support regional groups that develop their own regional Manure Application Advice or in other ways contribute to the advice systems. So, the Manure Application Advice should be more open to different versions on regional level.

Within both cases, actors point out the consequences of integrating these new modes of knowledge production into research designs and advice systems. First of all, knowledge creation should be put in the open and be made transparent, so that others can judge it for themselves. Secondly, the process of going from universal knowledge to local knowledge and back again should be part of the scientific research. Thirdly, farmers need to adjust these new sources of knowledge to their management decisions and learn how to deal with these new kinds of information.

8. Conclusions and further considerations

8.1. Introduction

Based on the case studies presented in this book, a number of conclusions can be drawn. Section 8.2. contains a synthesis of the character of the new manure regime that is emerging in Dutch dairy farming. In section 8.3., it is argued why storylines are a viable form of knowledge production. In section 8.4., the new role of scientists in the emerging new knowledge infrastructure is discussed.

8.2. Understanding the manure regime in Dutch dairy farming

After the 1980s, several experiments to change the dominant manure regime have taken place. These experiments were carried out at different locations, e.g. local farms, research stations and nutrient management projects. In the latter, farmers and scientists started to work together to experiment with novel nutrient management practices for sustainable dairy farming. From these experiments, a wide range of management options and guidelines for nutrient management were developed to be used by farmers in the Netherlands to improve their farming system in accordance with the sustainability demands set by the government.

The nutrient management projects that have been developed in response to the crisis in the modern manure regime showed different 'Evolving Good Agricultural Practices.' First of all, the nutrient management projects had set different priorities in terms of 'what to know.' *Koeien en Kansen* and *Praktijkcijfers* considered it as their priority to develop the codes of conduct of the government's idiom 'Good Agricultural Practice', which they aimed to disseminate to the dairy farmers. These projects wanted to develop knowledge in order to achieve the sustainability targets set by the government policies. Projects such as *Bioveem* focused primarily on the development of farming systems that incorporate standards set by the organic movement. Projects like VEL and VANLA, PMOV and *Slim Experimenteren* also focused on developing nutrient management options at the farms that meet the standards set by the government, but clear priority was given to the development of alternatives to the dominant regime. Secondly, the projects also had different views on 'how to know.' All projects incorporated farmers' knowledge in the research design, but at different degrees. *Bioveem* and VEL and VANLA considered farmers' knowledge as the basis of innovation whereas *Koeien en Kansen* and *Praktijkcijfers* considered farmers' knowledge as an important part of research design, but not decisive for the innovations that were investigated.

The Nutrient Management Project of VEL and VANLA was established at the same time as other projects, e.g. *Koeien en Kansen* and *Praktijkcijfers*. The novelties proposed and researched by the actors of VEL and VANLA were criticizing the dominant innovation models and the epistemology regarded as dominant within these projects. During the research activities of the Nutrient Management Project of VEL and

VANLA, the actors started to share a set of storylines in which they found alignment to work together. One way the narrators of the storylines build a common understanding was by narrating the David vs. Goliath plot. This is a version of Strategic Niche Management in which the actors radically aim to change the existing regime. This David vs. Goliath plot shows similarities with the work of proponents of the rural development paradigm (Marsden, 2003) and multifunctional agriculture (Van der Ploeg and Roep, 2003). So, although the VEL and VANLA Nutrient Management Project was part of the national programme of 'nitrate projects' and served primarily as a dissemination project towards the region, the farmers and scientists started to experiment with an alternative to this national programme. The protected space that was created (in terms of finances and regulation) allowed the farmers to experiment with their own novelties towards a regime change in the Netherlands. Apart from finding new management practices to deal with manure (formulated as the storyline of making good manure), they also experimented with new design options for agricultural research (formulated as the storyline of the systems perspective). The connection between the majority of actors within the Nutrient Management Project of VEL and VANLA is that they started to attach a shared significance to their activities and practices and created internal coherence through this evolving set of storylines about manure.

In the course of time, the carrying network of the storylines of VEL and VANLA was expanding and the storylines, as well as various artefacts, started to travel and get modified within various communities of practice. The systems perspective is an example of such a new artefact. There were also new programmes, like the 'Project on the Manure Application Advice' and new research programmes that incorporated elements of the storylines. Private persons also joined farmers to promote the new management options to make good manure, as we have seen in the case of manure application technologies. The government also decided to develop several initiatives to investigate and stimulate the incorporation of the storyline of good manure within the manure regime. So, we can conclude that the storylines became effective and gained external power in the course of time. The consolidated storylines created opportunities for new alignment between actors, necessary for niche branching which might lead to a regime change.

There is a dual relationship between the openings that were created within the regime and the actors who opened up the regime. The farmers and scientists of VEL and VANLA were able to start new practices because of public awareness about the environmental crisis and because they became a protected space, i.e. they were one of the first to receive support from the government and in this way they could experiment with alternatives to the regime. At the same time, because of their constant lobbying and the storylines they developed and communicated, they created new openings at various places in the regime. In other words, this dual relationship is a form of co-evolution or 'circular causality.'

In general, a new niche has emerged that has characteristics that are deviant from the dominant regime. First of all, there is an increasing network of actors that celebrate diversity in entrepreneurship in dairy farming, resulting in the production of different qualities of milk, beef, manure, landscapes, breeds of cows, technologies and farming systems. Secondly, there are farmers that develop localized versions of dealing with manure excretion and manure application. Related to this are the regional groups and environmental cooperatives that develop regional solutions. A consequence of this is that regional diversity in knowledge reservoirs emerges as different communities of practice increase their specific knowledge base, fitting into their localities. Finally, there are various experiments with forms of deregulation and self-governance which is a response to the need for combinations of top-down and bottom-up planning of nutrient policies. In this niche a new rule-set is emerging, based on diversity, locality and self-regulation. What once was marginal and invisible within the dominant regime, now gains new value because of new societal demands. Farmers become key agents in rural development again, because they actively develop long-forgotten, but highly relevant, concepts and practices and their expertise is of high importance. These new practices and interactions are getting more and more institutionalized, e.g. in regional groups that focus on joint entrepreneurship and knowledge exchange and research projects that integrate knowledge development among different target groups.

The different case studies in this thesis exemplify that regime change is not only about institutional change, i.e. the rules on how to act or not to act but that regime change is also about epistemological change, e.g. the ideas on ‘what to know’ and ‘how to know’. The actors presented in this book have created different storylines that travelled and had their influence on the dominant ways of thinking within science and political institutions. For example, the farmers and scientists in VEL and VANLA not only formulated storylines about management processes at the level of the farms, but also about the knowledge practices at the academia, the epistemological positions within the academia, as well as the consequences of incorporating farmers’ knowledge for the institutions of the agricultural sciences. At the same time, similar versions of these storylines (e.g. the importance of the systems perspective and the need to invest in a new knowledge infrastructure) were developed in other communities of practice as well, and through the linkages that occurred, the promising novelties could become more robust within the emerging new niche.

One other conclusion can be drawn about the role of the knowledge infrastructure in regime change. Although it has become more and more acknowledged that scientific knowledge does not necessarily represent the objective truth, it seems that it is not communicated to the outside world very often. More and more scientists have become aware that scientific knowledge is considered to be robust when it is accepted by one of the several scientific communities of practice. Therefore, scientific knowledge is also contextual knowledge, but in another temporal, spatial and social context than that of farmers’ knowledge. However, whereas this view of science may be accepted more and more by the scientists themselves, it is not often expressed by scientists when they communicate with the outside world (Leeuwis *et al*., 2006). Internal tensions within the scientific community tend to be shielded from the outside world and conflicting views and controversies are not to be brought out into the open (*ibid*). One challenging aspect for scientific communities is the fact that the 'social' construction of all forms of knowledge is made more transparent to outsiders, and that it becomes clear that scientists are actively engaged in this process (see Leeuwis *et al*., 2006; Roep and Wiskerke, 2004; Baars, 2002,) even when this is accompanied by struggle and conflicts about competing knowledge claims.

It is important to prevent a too fast lock-in of novel configurations within the evolving communities of practice. Better it is to invest in different versions of 'Evolving Good Practice' instead of focussing on one 'Good Agricultural Practice.' Therefore, the design options and innovation models should be clarified from the beginning. When the communities of practice are dominated by actors that emphasize linear models of innovation, this might imply an early lock-in of certain novelties at the expense of others. This in return, may have a reverse effect on achieving a patchwork of options at regime level. Or even worse, it might lead to undesired effects of regime change. So, it is important to nourish the great variety in opinions and to consider different views on regime change as viable options for reaching sustainability. This has consequences for the organizations that are appointed to steer regime change in dairy farming in the future. It is important, or more precisely absolutely necessary, to protect and foster those communities of practice that are deviant from or in conflict with the dominant ways of thinking. This is important, because these communities of practice might contain hidden novelties with radical routes to sustainability.

The final point of this section is in line with this and is about the case of manure application technologies. A new community of practice has emerged with its own cognitive knowledge reservoir, which questions the existing policies on manure application and underlying knowledge claims in the Netherlands. This debate has been taking place for more than a decade and now the body of knowledge developed is robust enough to be investigated. At present, the Dutch government can take up the task to reconsider the claims and storylines behind their policies and compare these with evolving claims that argue that farmers develop alternative routes that are equally valuable to achieve sustainability demands.

8.3. The roles of storylines in knowledge production, niche formation and regime change

The chapters in this book showed the rise and consolidation of three storylines: the storyline of good manure, the storyline of the systems perspective and the storyline of David vs. Goliath.

The storyline of good manure

The common theme of the storyline of good manure is that when the farmers make adaptations to management activities it is possible to make good manure. Crucial to this storyline is that is also possible to improve the nutrient efficiency of the total system. By adjusting various elements of the farming system, good manure can be made; manure that is good for the soil, good for the environment and good for the farm. The storyline of good manure emerged as a result of the experiences of the farmers with regard to manure practices within the Nutrient Management Project of VEL and VANLA. Farmers and scientists told each other about the surprising discoveries they made within their own practices. In processes of conflict and alignment that followed, the common storyline of good manure emerged and artefacts were produced (scientific results, guidelines, handbooks) that made the storyline more robust.

The storyline of the systems perspective

The common theme of the storyline about the soil-plant-animal system is that when science looks at farming in a system-integrated manner, other knowledge becomes visible that can serve as a meaningful clue to find solutions for the future. The systems perspective emerged as a novel way of thinking within the agricultural sciences, because in the old way of thinking the focus was solely on parts of the system. The systems perspective is put forward as a new option to change the dominant epistemology of the agricultural sciences.

The storyline of David vs. Goliath

The David vs. Goliath plot reflects a storyline about how things should be in a perfect world. The storyline implies that it is absolutely necessary and possible to realize a regime change. Farmers and scientists have found one another in the story about a failing manure regime and in the possibility of finding new solutions in practice. David (i.e. the farmers) incorporates resistance to Goliath (i.e. the existing regime), and in this storyline David will defeat Goliath by means of the niche the farmers and scientists attempt to create. In this storyline, the farmers play an active role in niche formation and regime change.

The two roles of storylines that can be distinguished are the role of creating internal coherence and the role of creating external power, which results in the emergence of a new knowledge reservoir. Storylines become more robust, because the (newly discovered) indicators that reflect and confirm the storylines, also create mutual understanding, internally and externally. Within the community of practice, the storylines provide a common framework for the farmers. When the storylines are then told and retold outside the community of practice, farmers and scientists start to speak a similar language, they ‘understand’ each other. Storylines and the associated indicators are therefore instruments that enable the farmers to get through to the outside world of science and politics, and in this way the storylines have an effect on niche formation and regime change. The three storylines mentioned above are carriers of a new knowledge reservoir emerging through knowledge production processes within the community of practice, i.e. the group of scientists and farmers that experiment with nutrient practices. This knowledge reservoir not only is altered as to contents (‘what to know’) but also in its way of knowledge production (‘how to know’).

The storylines gave the actors the opportunity to create mutual understanding on what is new and innovative within the experiments. To make the storylines more robust, different forms of alignment were necessary. Within the Nutrient Management Project, individual experiences with good manure were accepted by one group of actors as proof, for example stories about Hoeksma's farm, stories told by farmers about the additives and stories told by farmers about the soil. Other farmers within the Nutrient Management Project needed the storyline to be more robust. In their opinion, proof cannot only be based on stories of individual farmers or experiences within farms, but needs translation into scientific language, indicators and management options. Other actors within the emerging carrying network asked for scientific evidence. Indicators play a special role in the process of making storylines more robust. Indicators are simplified representations of complex phenomena. The indicators (i.e. professional terms used by the farmers and scientist) enable the farmers and scientists to speak the same language. When farmers and scientists use the same terms when they refer to complex phenomena, they more or less assume that they are all talking about the same meaning and interpretation. The indicators suggest a common understanding of the complex phenomena. This means that farmers and scientists have a shared perspective. For instance, in chapter 4 and 5 we have seen that the smell and consistency (thickness) of manure are used as indicators for the complex phenomenon of the quality of manure. For a specific group of actors, thick manure is an indicator for a sustainable way of farming and a trajectory for sustainable agriculture.

Storylines can also alter the knowledge reservoir by the creation of external power. When the storylines are laid down in scientific articles and manuals, the storylines and the associated indicators are recognized and considered as more robust knowledge in other communities of practice, like new experiments, government bodies and scientific institutions. Storylines also get external power when the storylines are embedded in evolving material practices. For instance, in the storyline of good manure, the quality of the soils, manure and cows is supposed to change into the quality of the soils, manure and cows the storyline narrates about. The storyline is reflected and confirmed in new indicators like feed and fodder of a different quality, the development of new breeds of cows and different qualities of manure. While the farmers and scientists experiment with making good manure, they create new entities like the storyline of the systems perspective, they discover new indicators and they produce new data and publications. These new entities, indicators, data and publications enter the domains of science, governance and management, thus creating external power.

8.4. Further considerations: Heterogeneous knowledge production

Sections 8.2 and 8.3 showed the rise of a new niche in which heterogeneity in knowledge production and related storylines is included as a way out of the dominant regime. This is not just a descriptive point: it so happens that knowledge production is more heterogeneous then has been assumed for a long time. There are good reasons to consider heterogeneous knowledge production as important, in general and in the present constellation of a regime that is opening up. Therefore the aim of this section is that agricultural scientists (being important knowledge producers) can remember some lessons about a number of aspects of knowledge creation within their heterogeneous practices. I will phrase my comments as addressed to agricultural scientists, because for them, working in heterogeneous knowledge production processes is a reality with a great responsibility. The points I make are general, however.

Lesson 1: Conflicts as valuable encounters in heterogeneous knowledge production

One of the tasks of agricultural scientists is to recognize other knowledge producers and to cooperate with them during heterogeneous knowledge production. For instance, within the Nutrient Management Project of VEL and VANLA, both agricultural scientists and farmers learned about manure practices by active cooperation and continuous negotiation. However, this type of cooperation is often accompanied with conflicts and differences in opinion. Cooperation and conflicts between farmers and scientists have been documented before (see Kibwana *et al*., 2001; Röling and Van der Fliert, 1998; Van Veldhuizen *et al*., 1997). In these studies, conflicts are treated as obstacles to learning. Development studies with an 'actor oriented approach' (see Long and Long, 1992) often treat struggle and conflict as an obstacle as well, instead of treating it as a challenge for knowledge production. In this section I will explain why conflicts are valuable encounters in heterogeneous knowledge production and why scientists should engage in these encounters.

As we have seen in chapter 4, conflicts (and connected to this, alignment) were part of the knowledge production processes within the Nutrient Management Project of VEL and VANLA. The question 'what is valid knowledge' often arose and there were conflicts on the validity of various types of knowledge. What can be learned from the case study of the Nutrient Management Project of VEL and VANLA about the value of conflicts? First of all, that it so happens that there are various categories of knowledge present when different stakeholders gather to produce knowledge. During their interactions, the actors automatically reproduce the various categories of knowledge (e.g. scientific knowledge and farmers' knowledge) discursively and give them a new meaning. This variety of sources of knowledge and their mutual confrontations is not an obstacle but a challenge during heterogeneous knowledge production. Therefore it is unwise to present one source of knowledge as superior and debunk other sources of knowledge. Instead, one should actively and intentionally discover the sources of knowledge that are present during the interactions. The conflicts that take place can serve as a good way to discover these various sources of knowledge and epistemologies. The conflicts sharpen the different standpoints and make the different sources of knowledge and their possible contributions to the overall knowledge production process more explicit. Secondly, parties are more inclined to accept knowledge when they have been involved in the generation of that knowledge. This is especially true when parties come into conflict. A lack of involvement may lead to rejection of one of the other bodies of knowledge (i.e. scientists' or farmers' experiments). Creating a sense of shared ownership of knowledge is conducive to that knowledge being accepted by all the parties concerned. In addition, being involved in a process of 'joint fact-finding' can bring conflicting parties together. This leads to a third conclusion: creating good relationships between parties within a community of practice is an integral part of contextual social learning processes. Forester (1999: 115) explains this: 'learning takes place not just through arguments, not just through the reframing of ideas, not just through the critique of expert knowledge, but through transformation of relationships and responsibilities, of networks and... membership'. One way to build good relationships is through the acceptance of different points of view. In this way a community of practice can arise in which the different participants 'agree to disagree' and consider disagreement as an important source of renewal.

Lesson 2: Nurturing new modes of knowledge production

When agricultural scientists aim to experiment with new kinds of knowledge production, they can search for new loci and arena to carry out their research. For instance, the knowledge in the Nutrient Management Project of VEL and VANLA was generated at the farms and in the fields of members of the cooperatives. The research design therefore challenged scientists to think about the nature of scientific activities. The 'Project on the Manure Application Advice' argued that more attention should be paid to regional groups that exchange information and increase the knowledge base on nutrient management. The 'Wageningen Working Group on Experiential Knowledge' argued that research projects should integrate other modes of knowledge in their research designs.

Within the Nutrient Management Project of VEL and VANLA, new modes of knowledge production are experimented with. Experiments on location are also part of the research design but these involve other elements than classical laboratory experiments. The central issue was to find patterns for developing ways towards sustainability. The following three modes of knowledge production can be distinguished from the case of the Nutrient Management Project of VEL and VANLA: exchange, circulation; natural history; controlled circumstances. These modes of knowledge production are derived from Rip (2002: 120).

Exchange, circulation

Knowledge is a by-product of actions of and interactions between local practices. When different actors meet and exchange their knowledge, new knowledge with an added value can be produced. Trans-locality of the knowledge takes place because of exchanging the knowledge with others. Exchange, circulation was the basis of the novelties formulated among the farmers and the researchers during the research council of the Nutrient Management Project and the study meetings. There is a risk that its robustness is scrutinized by others, as we have seen in the controversy about additives and manure application technologies. Therefore ways to monitor the processes of exchange, circulation are important.

Natural History

Natural history means that knowledge is the outcome of the collection and accumulation of experiences and findings across space and time. Examples within the Nutrient Management Project are the field studies of Sonneveld and Bouma (2003) and Groot *et al.* (2003). The emphasis is on collecting, systematizing and classifying observation in space and time, to find patterns and routines. The systems perspective of the Nutrient Management Project is another example of creating such a coherent pattern. The actors try to make an overall system more explicit and consequently recognize meaningful patterns within this system.

Controlled circumstances

Knowledge as the outcome of (experimental) findings under controlled circumstances. Some of the research in the Nutrient Management Project of VEL and VANLA is based on experiments under controlled circumstances (e.g. Van Vliet *et al*., 2007; Van der Stelt, 2007). Research was also performed with semi-permeable boundaries, like the research on location at the farms of Sikkema and Hoeksma (Schils and Kok, 2003). This implies that there can be a mixture of two modes of knowledge production; in this case, exchange, circulation and controlled circumstances.

Lesson 3: The role of boundary workers in heterogeneous knowledge production

When an agricultural scientist experiments with heterogeneous knowledge production, the boundaries between science and non-science become part of his reflexive research design. During the processes of knowledge creation, various productive arrangements between experts (not only scientists) are formed who combine and develop knowledge from various sources, whether it is scientific or layman's knowledge. Participatory approaches in the social sciences state that these various sources of knowledge have an important role to play in bringing about sustainable innovations in agriculture (Leeuwis and Pyburn, 2002; Chambers 1983; Hobart 1993; Kolb 1984). There are other examples of scientific projects in which the explicit use of non-scientific knowledge is manifest as well, like the work of Ellis and Waterton (2005) on the use of knowledge of fishermen in biodiversity planning in the United Kingdom. The category of non-scientists as innovators was often brought forward at the meetings of the Nutrient Management Project VEL and VANLA as well. The theories of Strategic Niche Management also mention the role of innovators. It is based on the assumption that the innovator is deviant from existing routines and knows how to break patterns.

While discovering local hypotheses and developing potential innovations, scientists are also boundary workers between science and practice. There are various competencies that boundary workers can develop. First there is the (multi-disciplinary) examination and support of various types of knowledge and expertise. Therefore, crucial responsibilities are the identification of (the principles that define) the work of innovators and methods how to cooperate with them (Roep and Wiskerke, 2004). Boundary workers need to broaden and deepen their understanding of the potential and transformative nature of these kinds of innovations. This requires considerably creative and analytical skills considering the high levels of embeddedness (Eshuis *et al*., 2001) and the spatiality of these new types of rural development (Renting and Van der Ploeg, 2001). Second there is the task to translate potentially interesting innovations for various audiences or target groups. Knowledge production (including scientific processes) contains processes of conflict and alignment although is it is often presented to the outside world as solid science. This creation of robust knowledge is a third task of boundary workers. The task of boundary workers is to develop these innovations by network-building, inducing learning processes and negotiations with several audiences (Roep and Wiskerke 2004).

Lesson 4: Heterogeneous knowledge production, at what costs?

Is it possible to routinize all these suggestions in a new regime? What are the institutional consequences involved? Heterogeneous knowledge production is institutionally weak because organization of knowledge production is still taking place along old lines of research and development, disciplines and classical experiments. These old routines need to be replaced, but by what?

The set-up of joint experiments in which various stakeholders work together, means that new ways of interaction and alignment between the various practices and knowledge need to be coordinated and made explicit in the research design. Since tacit knowledge of the various actors within the experiments is difficult to transfer, the storyline capacity of people needs to be enhanced because it can make tacit knowledge more explicit (Polanyi 1967). Therefore a knowledge base, to understand and monitor these processes of knowledge articulation needs to be developed. As we have seen, negotiations on epistemological differences are inevitable and attention has to be paid to several types of learning, for instance triple-loop learning (Kolb, 1984). Furthermore, when agricultural scientists aim to experiment with new kinds of knowledge production, they need to learn how to search for new loci and arenas to carry out research. This takes time and involves risks, since finding new sites and 'pearls of innovation' is very expensive, with potentially high implications, but with low rewards at the beginning (Groen *et al*., 2006).

Searching for new experiments and places of knowledge production involves high costs of organization for the various actors involved. For instance: new criteria for scientific quality need to be developed, which include societal and political aims as well. Plus: scientific research should not only focus on the target group of the scientific community, but should also outline other communities of practice that could benefit from the research. Evaluations of research procedures should take into account whether the research has been profitable for these various target groups (Royal Netherlands Academy of Arts and Sciences, 2005).

Agricultural scientific institutions therefore need to reposition themselves, which includes institutional changes. This reorientation needs to take place at the level of epistemologies, but also at the level of reward structures (Stuiver and Wiskerke, 2004). A new community of scientific practice needs to be developed, which allows these new forms of heterogeneous knowledge production to be monitored and rewarded within the academia. Up until now classical peer-reviewed articles are the criteria for rewards of scientific research. What the agricultural sciences need to do is to develop a monitoring tool to understand and value the contribution of scientists to heterogeneous knowledge production. Therefore the decision-making bodies need to be entrepreneurial themselves in their application of funds and finances to scientific departments and transition organizations. There is a need for a re-allocation of funding to departments and institutions that favour heterogeneous knowledge production and express the various views of stakeholders on the societal relevance of the research involved.

Closing remarks

By addressing the importance of heterogeneous knowledge production, the implication is that heterogeneity as such is valuable in the present stage the manure regime is in. Therefore it is important to safeguard heterogeneity in this stage. In other words, although some of the new approaches are promising and interesting (for example the approach as put forward in the Nutrient Management Project of VEL and VANLA) one specific approach should not be put forward and promoted as the main approach. The danger would be to create a lock-in at a premature stage, now for an alternative regime, but with the same problems of dominance that the modern manure regime experienced (and still experiences). Of course, when the situation in the future might occur that there is general understanding (now among all heterogeneous stakeholders) that one certain approach with its institutional consequences is definitely the best; a lock-in may be acceptable. Although I would argue that within every regime that stabilizes, there should be a shared understanding that openings for ‘pearls of innovation’ are treasured.

The question, also for this thesis as a whole, is thus about the diagnosis of the present situation: the modern regime is opening up, new endeavours have appeared to be productive, and how long should one continue to experiment and keep all the options open? Rip (2000a) has argued, for the overall regime of modern science in society, that it is important to not yet settle for the presently emerging regime of ‘strategic science’, because in the institutional constellation that appears to prevail, that would close down further, and possible important options. Similarly, one should diagnose ongoing regime change in agriculture, using analysis and conceptual frameworks as in this thesis, before embracing one or another overall approach.

Notes

i Vereniging Eastermar's Lânsdouwe (VEL) and Vereniging Agrarisch Natuur en Landschapsbeheer Achtkarspelen (VANLA).

ii This chapter is partly based on Stuiver (2006).

iii I derive this approach to storylines from Czarniawska-Joerges (1998) and Polkinghorne (1995) who view narratives as a succession of incidents into a signified episode (and not like others who use any form of communication as narrative).

iv The concept of storylines shows similarities with concept of narratives. Bruner (1986) defines narratives as written or spoken representations of a sequence of events, gathered and put into meaning by means of a plot. Narratives are a discourse form that implies knowing about, or having knowledge about, something that happened or is happening. The noun 'narrative' is connected to the verb 'to narrate', which means to tell a story in detail. A narrative requires at least three elements: an original state of affairs, an action or an event, and the consequent state of affairs. These different elements that are narrated about, form a so-called plot. Narratives are a research topic in a growing number of disciplines. Within consumer research, social sciences and cognitive psychology are combined in focusing on narrative construction of identities and food consumption (Shankar *et al*., 2001). Within the biomedical sciences, cognitive psychology is combined with socio-linguistic narrative analysis to research people's medical cases (Mildorf, 2002). Within the political sciences, discourse analysis and policy research are combined to understand the politics of narratives (Hajer, 1995).

v This chapter is partly based on Stuiver and Wiskerke (2004a).

vi The study of Van der Ploeg *et al.* (1999) shows that the agronomist and chemist Carl Sprengel conducted pioneering research in agricultural chemistry during the first half of the 19th century. In 1826, he published an article in which the humus theory was refuted. In 1828, he published an article on soil chemistry and mineral nutrition of plants that contained the Law of the Minimum. Sprengel's doctrines are presented again in the books published by Von Liebig in 1840 and 1855 (Van der Ploeg *et al*., 1999).

vii Gibbons *et al.* (1994) describe the dominant mode of knowledge production in modernization as Mode I. They argue that we are now in a stage of moving from Mode I to Mode II. Mode I focuses on knowledge production within the academia. This knowledge production is not necessarily linked to the context of application. Mode II on the other hand focuses on research and knowledge activities performed within the context of application and can be driven by a broad range of societal interests. Here we see that Mode II type of practices existed during modernization as well. Gibbons *et al.* (1994) also state that the research novelties within Mode II are not new, but that they rather need more room to develop.

viii Schot *et al.* (2000) argue that the role of farmers in innovation has been overlooked. In his view, they did play a role in the modernization of agriculture. An example of this is the study groups existing among arable farmers, in which the participants compared their plant breeding novelties, use of concentrates, fertilizer and pesticides. Also the art of making silage, and artificial insemination were innovations that started among dairy farmers (Schot *et al.*, 2000 page 232).

ix In this section I focus solely on the environmental crisis in the manure regime. Dairy farming was faced with many other problems during the last decades, e.g. the vulnerable position of the Dutch dairy sector in a changing international market, the decreasing labour opportunities, the problems of animal welfare and the outbreaks of diseases.

x Frouws (1993) argues that the lack of anticipation of these environmental problems by the agricultural policy community can be traced back to the corporate structure of the agricultural sector. The mutual interests of the APC created a status quo and the closed character of this agricultural 'bastion' led to an attitude of denial of environmental problems. The ruling modernization paradigm created 'blindness' to the negative side effects of agricultural policies. Termeer (1993), Frouws (1993), and Bloemendaal (1995) all conclude that this denial and lack of anticipation of environmental problems was maintained for a long time, because of the limited interaction between the APC and other outside actors. In addition, relevant actors outside the APC (i.e. environmental groups) were less well organized (Frouws, 1997).

xi Between 1 September and 1 February there is a ban on manure application on grassland soils susceptible to nitrate leaching. Between 15 September and 1 February there is a ban on manure application on other grassland soils.

xii The existence of a dominant way of dealing with manure and fertilizer during modernization did not mean that other approaches did not exist. There have always been approaches to farming, like organic farming that developed alongside, or because of the dominant regime. There have always been farmers that had different styles of farming that were deviant from the aims of high productivity and focused on low costs, quality production and nature conservation (Van der Ploeg and Long 1994).

xiii Already in the fifties there were scientists who mentioned the shortcomings of the approach to farming developed during the modern regime. Hudig (1955): 'For 60 years, they thought that they have arrived at the right place: they said: Put all the nutrients in the soil, buy the best seeds and drain the soil in time and there is nothing left to be desired.' And: 'Manure practices have gone in one direction, where the use of green fertilizers has been neglected. As a consequence, everywhere in the world the soil is exhausted.' He stated that it is important to look at the processes in the soil, where nutrients, but also micro-organisms play a vital role (Hudig, 1955) 'The soil is not a substrate, where one can put things in. No, the soil is an active environment that interacts with the chemical and biological reactions of plants and micro-organisms' (Hudig, 1955). Hudig concluded with the following sentence: 'May the contents of this book add to the understanding that we, in our present times, still have to focus on the goal to keep soil fertility.' Rinsema (1953) also gave arguments for concentrating on a better use of animal manure. He said that animal manure is relevant to several aspects of grassland management, like a good structure of the soil, the development of micro-organisms and mychoriza and the delivery of nutrients (Rinsema, 1953). He stated that it is important to make good use of both fertilizer and animal manure.

xiv Kloppenburg (1991) argues that scientists should take into account local knowledge and he argues for an enhanced role for farmers. More descriptions of cooperation between farmers and scientists can be found in literature dealing with learning processes (see Kibwana *et al*., 2001; Röling and Van der Fliert, 1998; Van Veldhuizen *et al*., 1997).

xv Organic farming started in the 1920s in England where a type of agriculture, that emphasized feeding the soil through compost, was introduced by Sir Albert Howard in the 1930s (Oelhaf, 1978). The work has been carried on by Lady Eve Balfour and the Soil Association of England, in which farmers cooperated together (Balfour, 1975). Organic farming is based on the principles of Rudolf Steiner (Steiner 1924).

xvi There are different types of criticism on the modern manure regime present within the organic movement. First of all, the organic farmers reject chemical fertilizers, not simply because these are chemicals but because they feed the plant rather than the soil. Secondly, crushed rock-phosphate is used in preference to the more soluble chemically-treated superphosphate. Thirdly, organic farmers are worried to become too dependent on supply industries and trade organizations.

xvii This chapter is based partly on Stuiver and Wiskerke (2004a) and Eshuis and Stuiver (2004).

xviii See appendix I for an overview of the meetings I attended.

xix Van Bruchem was controversial in the eyes of many because he investigated the use of additives (Van Maanen 2003b) and he also argued for an integration of different worldviews in science (ibid). His drastic view on fertilizer as the source of all problems was debated within the academia a lot (see, e.g., Bouter, 2003).

xx The C/N ratio in manure depends on the amounts of protein and fibre (which contains C) used in the feed and fodder (Lantinga and Van Bruchem, 1999).

xxi Van der Ploeg at that time made some strong claims that made him famous in the farming community and in the scientific community. In his book, the Virtual Farmer, his claims were synthesized and they caused a heated debate at the time of publication (Van der Ploeg, 1999).

xxii I have been at Hoeksma's farm very often and observed discussions between him and extension workers and researchers (e.g. Van der Ploeg). See also the Virtual Farmer (Van der Ploeg 1999).

xxiii A cubicle stable is a stable for keeping cows. It is composed of a dwelling area for animals, a feeding area with a floor for foodstorage and feeding, and a partition between the dwelling area and the feeding area with openings, allowing the heads of animals in the dwelling area access to the feeding area (Weelink, 1995).

xxiv A nitrogen balance is the difference between the amount of nitrogen taken in and the amount of nitrogen excreted or lost. Farm nitrogen efficiency is nitrogen in milk and meat divided by the nitrogen in feed and fodder and fertilizer. Cow nitrogen efficiency is nitrogen in milk and meat divided by nitrogen of feed and fodder. Soil nitrogen efficiency is nitrogen in fodder divided by nitrogen in manure and fertilizer.

xxv Verhoeven came to know the Nutrient Management Project when he calculated the nitrogen balances. He was the project leader of the Nutrient Management Project until 2004. He published several articles about the Nutrient Management Project and was the editor of several books and journals (see Verhoeven *et al*., 2003a; Verhoeven *et al*., 2003b). He also represented the Nutrient Management Project in the Experiential Knowledge working group (see chapter 7).

xxvi At the same time, the research group of Van der Ploeg started an extensive study of the farmers in the area, to map the different attitudes of farmers towards animal manure and fertilizer (Eshuis *et al*., 2001: 21). The study distinguished four ways of making manure. The third and fourth way, which are actively working on the quality of animal manure, showed a lot of similarities with the practices of the farmers of the project that already had experience with managing nitrogen flows at their farms since the start of the environmental cooperatives within the scope of the governance experiment (see also Benedictus *et al*., 2001). Many of these farmers became part of the Euromanure mixture group.

xxvii It was possible for Reijs to make farm comparisons as the project had invested in a central database that contained all relevant data of the 60 farms. Both the farmers and scientists had, to a certain degree, free access to this database. The question as to what data are relevant to collect was discussed among the scientists and farmers. The ideas developed in the course of time, resulting in a wide and dense account of the dynamics of the farms.

xxviii Indicators that Reijs used were crude protein (RE), fibre (RC), sugar, starch and OEB. RE stands for the amount of protein in the total diet, RC stands for the amount of fibre in the total diet. OEB is a direct indicator for the surplus of protein in the diet.

xxix De Goede *et al.* (2003) estimated that earthworms contribute 85 or 170 kg N ha-1 year-1 to gross N mineralization in grasslands fertilized with fertilizer or with cattle manure slurry, respectively (Van Vliet *et al*., 2007).

xxx Nitrogen uptake occurs as the plant absorbs nitrogen from the soil root zone.

xxxi Farm labour can be considered to be the purposeful coordination of the interaction between the producer(s), his or her labour objects (land, cattle and crops) and resources (machines, tools, inputs). (Bruin, 1997; Van der Ploeg, 1991b). Farm labour is the coordination of subtasks, e.g., milking, mowing, making silage, the application of manure to the land. The resources are used to make the objects of labour increase in value. 'This is not a mechanical process but highly dependent on the ways, or styles of farming'' (Bruin 1997:33). Farming is a socio-technological practice. It encompasses concepts, ways of acting and knowing and the development of technological hardware within the practice of farm labour (see Eshuis *et al*., 2001).

xxxii While participating in the Nutrient Management Project, we published in Eshuis *et al.* (2001: 21), that dairy farmers at that time had 4 main methods for working with animal manure. Method 1 and 2 were dominant during the modern manure regime at the end of the nineties. Method 3 and 4 have similarities with figure 5.2.

Manure as by-product: Using fertilizer, owning and dumping animal manure (method 1)
Manure as by-product: Using fertilizer, owning and using animal manure (method 2)
Manure as focus: Making animal manure and using animal manure, adapting the use of fertilizer (method 3)
Manure as focus: Making animal manure and using animal manure, abandoning the use of fertilizer (method 4)

xxxiii Reijs used the interviews for his doctoral research (Reijs, 2007) to understand the social dimension of the manure practices.

xxxiv Perennial ryegrass is *lolium perénne*, timothy is *phleum pratense* , rough meadow grass is *poa triviális*. Cough grass is *Elytrigia repens*, crane's bill is *geranium phaeum*, marsh foxtail is *alopecurus praténsis*.

xxxv In 1992 the farmers founded Vereniging Eastermar's Lânsdouwe (VEL) and Vereniging Agrarisch Natuur en Landschapsbeheer Achtkarspelen (VANLA), being among the first environmental cooperatives in the Netherlands. In 2002 the VEL had 65 members who manage 1,600 hectares. The VANLA had 144 members who manage 3,550 hectares. An environmental cooperative is a regional organization of agricultural entrepreneurs, often working in close collaboration with other rural stakeholders (e.g. environmental organizations, local authorities, animal welfare groups and citizens). They aim to integrate environmental, conservation and landscape objectives into their farming practices.

xxxvi She was the Director of the Ministry of LNV at that time.

xxxvii The Green Hart is a densely populated area in the West of the Netherlands, which is characterized by its rural character which contrasts the urban areas around it (www.wikipedia.nl).

xxxviii Verhoeven is the project leader of the VEL and VANLA Nutrient Management Project (see chapter 4 and chapter 6). Baars is scientist at the Louis Bolk Institute, a research institute in the Netherlands that focuses on the promotion of organic farming and the introduction of the systems approach in agriculture. Galama is the project leader at experimental farm de Marke and involved in the Koeien en Kansen project. Spoelstra is programme leader of the project: Future Livestock Production Systems. Sierk writes in of his columns: 'Do you remember what OVO means? It used to be the Dutch term for the system of knowledge management of the Ministry of LNV. We were proud of our system of Onderzoek (Research), Voorlichting (Extension) and Onderwijs (Education). Nowhere in the world, the transfer of new results from science to practice seemed so efficient. Obviously OVO does not exist anymore. The questions we deal with are more complex; sustainability issues are international issues; Extension and Education are privatized. We have to find other ways of knowledge development and knowledge transfer. My programme contributes to this by organizing innovation trajectories based on learning networks' (Spoelstra, 2004:1). Proost is freelance consultant communication and staff member of the WU Chair Group Communication and Innovation Studies. She is involved in farming systems research, especially the interactions between scientists and stakeholders within joint knowledge development routes.

xxxix The term boundary-work comes from Thomas Gieryn who refers to situations in which boundaries between fields of knowledge are created or attacked. In his book he argues that there are no clear criteria that demarcate science from non-science (Gieryn, 1983).

xl Other adjustments like the differences in grazing and cutting of the grassland, or the quality of the soil were examined but not introduced (Corré and Dijkman 1988; Mooij and Vellinga 1992).

Summary (in Dutch)

Onderzoeksvraag

Met dit proefschrift wil ik een bijdrage leveren aan een beter inzicht in de overgangsfase waarin het moderne mestregime in de melkveehouderij zich thans bevindt. Het onderwerp van onderzoek ligt op het punt waar twee maatschappelijke ontwikkelingen elkaar kruisen: enerzijds de veranderingen in de rol van de landbouw en anderzijds de veranderingen in de manieren waarop kennis wordt ontwikkeld evenals de veranderende zienswijzen ten aanzien van het ontwikkelen van kennis. De overgang naar duurzame landbouw dient te worden bevorderd door inzicht in en kennis van duurzame manieren van bedrijfsvoering. Veel professionals stellen dat de traditionele manieren waarop kennis wordt ontwikkeld hiervoor niet toereikend zijn. Nu het mestregime onder druk staat, wordt de vraag: 'welke kennis is belangrijk' ook steeds vaker op de agenda gezet. Het is dan ook de moeite waard om het ontstaan van kennis in heterogene groepen van actoren, zoals melkveehouders, netwerken van melkveehouders en regionale groepen, te onderzoeken.

Dit onderzoek richt zich op de praktijken waar melkveehouders en wetenschappers experimenteren met het vinden van innovatieve alternatieven voor het mestregime, en op de manier waarop deze praktijken onderdeel uitmaken van veelomvattende structuren en ontwikkelingen. Ik benader het onderwerp vanuit een sociologisch perspectief, waarin epistemologische aspecten van innovatie, het ontstaan van niches en verandering van regime een centrale rol spelen. Daarvoor introduceer ik het concept van verhaallijnen. De actoren richten zich niet alleen op het ontwikkelen van innovatieve manieren van bedrijfsvoering, maar zij vertellen ook over deze ontwikkelingen door middel van gemeenschappelijke verhaallijnen, waardoor deze innovaties, ook in andere domeinen, betekenis krijgen.

Onderzoeksvragen

1. Wat is het huidige mestregime in de melkveehouderij in Nederland en hoe heeft deze zich in de loop der tijd ontwikkeld?
2. Welke innovaties en kennispraktijken hebben zich ontwikkeld in antwoord op de crisis in het huidige mestregime?
3. Welke verhaallijnen zijn er ontstaan ten aanzien van innovatieve mest praktijken binnen het Nutriënten Management Project van VEL en VANLA en hoe hebben deze zich in de loop der tijd ontwikkeld?
4. Welke bijdrage leveren deze verhaallijnen aan het ontstaan van niches en de verandering van het regime in de melkveehouderij in Nederland?

Theoretisch perspectief

Om de processen van innovatie te onderzoeken zal ik deze processen vanuit een institutionele benadering bekijken. Deze benadering is uitermate geschikt voor mijn onderzoeksvragen omdat hiermee epistemologische vraagstukken die zijn verbonden aan institutionele vraagstukken kunnen worden onderzocht. Strategic Niche Management is een regime benadering die zich op meerdere niveaus afspeelt, waarbij meerdere actoren zijn betrokken en waarbij meerdere aspecten een rol spelen. Het richt zich op de wijze waarop innovaties in plaatselijke experimenten kunnen worden beschermd zodat nieuwe ontwikkelingen en inzichten tot volle wasdom kunnen komen terwijl deze tegelijkertijd, kunnen leiden tot niche branching en een mogelijke verandering van het regime. Om de ontwikkeling van kennis door wetenschappers en melkveehouders in deze experimenten te onderzoeken, wordt de institutionele benadering aangevuld met het concept van verhaallijnen. Verhaallijnen ontwikkelen zich binnen deze 'communities of practice' om betekenis te geven aan de sociale en fysieke activiteiten van de betrokkenen. Tijdens experimenten en het creëren van niches, ontwikkelen en testen de desbetreffende actoren niet alleen de innovatieve socio-technologische configuraties, maar ze streven er ook naar om een gemeenschappelijke verhaallijn te vinden die een betekenis geeft aan deze configuraties en die boven het experiment uitstijgt.

Materiaal en methoden

In dit proefschrift doe ik onderzoek naar innovaties en kennispraktijken die zich de laatste jaren zijn ontwikkeld door heterogene groepen actoren in antwoord op de crisis in het huidige mestregime. Ten eerste heb ik onderzoek gedaan naar de experimenten binnen het Nutriënten Management Project van VEL en VANLA in Friesland, Nederland. De melkveehouders van VEL en VANLA werkten samen met landbouwwetenschappers aan nieuwe mestpraktijken om milieuvervuiling tegen te gaan, wat leidde tot de start van het Nutriënten Management Project van VEL en VANLA in 1998. Ik heb van 1999 tot 2004 deelgenomen aan het project en onderzoek gedaan. Ik heb gegevens verzameld door middel van interviews en participerende observatie tijdens studiebijeenkomsten en bijeenkomsten van de onderzoeksraad. De tweede groep experimenten waar ik mij op richtte omvatte de nieuwe manieren van bedrijfsvoering van acht melkveehouders. Met iedere melkveehouder heb ik gekeken naar zijn manier van omgaan met mest. Ik heb ook de relevante gegevens en indicatoren verzameld om inzicht te krijgen in de concrete ontwikkelingen op dit gebied binnen hun bedrijf. De derde groep van experimenten die ik heb onderzocht betreft de pogingen van melkveehouders en wetenschappers om het bestaande regime te veranderen. Ik heb een diepgaand literatuuronderzoek gedaan. Ik heb deelnemers aan het Nutriënten Management Project geïnterviewd over hun pogingen om het regime te veranderen en ik heb betrokkenen geïnterviewd om een overzicht te krijgen van de diverse argumenten en standpunten. Ik heb mij daarbij gericht op het ontstaan en verspreiden van de verhaallijnen binnen andere nutriënten management projecten in Nederland zoals 'Koeien en Kansen', 'Bioveem', PMOV en 'Praktijkcijfers'. In de vierde groep van activiteiten die ik heb onderzocht kon ik mijn deelname aan twee onderzoeksprojecten als uitgangspunt nemen; de 'Ervaringskennis Werkgroep' en het 'Bemestingsadvies Project' van Wageningen Universiteit en Research Centrum. Ik heb gebruik gemaakt van deze projecten om meer te weten te komen over mogelijk nieuwe vormen van kennisproductie die interessant zijn voor de academische wereld, onderzoeksprojecten en adviessystemen.

Door onderzoek te doen naar deze verschillende experimenten en activiteiten heb ik de verhaallijnen en de manier waarop deze zich hebben verspreid kunnen ontrafelen. De eerste methode om de verhaallijnen te ontrafelen was het volgen van de vertellers van de verhaallijnen en de manieren waarop zij de verhaallijnen hebben verwoord binnen de experimenten en activiteiten waarnaar ik onderzoek heb gedaan. Ik heb gekeken naar de experimenten die ze hebben uitgevoerd en naar hun pogingen om niches te creëren. Ik heb dit gedaan door middel van interviews, participerende observatie en het analyseren van de omstandigheden. De tweede methode omvatte het onderzoeken van de artefacten die er mede voor hebben gezorgd dat de verhaallijnen voet aan de grond kregen binnen het dragende netwerk. Voorbeelden zijn schriftelijk materiaal (zoals artikelen, verhandelingen en lezingen), afbeeldingen, technologieën en databases.

Overzicht van de hoofdstukken

Hoofdstuk 3 beschrijft drie periodes in de ontwikkeling van het mestregime binnen de melkveehouderij in Nederland. De eerste periode wordt gekenmerkt door de wetenschappelijke ontdekkingen op het gebied van minerale stoffen die de basis vormden van het mestregime. De tweede periode staat voor de stabilisatieperiode van het mestregime, met een kennisinfrastructuur die sterk gebaseerd is op het algemene paradigma van modernisatie. De derde periode betreft de periode waarin het mestregime en de daarmee verbonden kennisinfrastructuur worden heroverwogen. Gedurende deze periode was er de kritiek dat het overheersende mestregime leidde tot 'slechte mest' en men zocht naar mogelijkheden om zowel het mestregime als de kennisinfrastructuur te veranderen.

Hoofdstuk 4 bevat de casus van het Nutriënten Management Project van VEL en VANLA. Melkveehouders en wetenschappers gingen samenwerken en kwamen tot diverse nieuwe inzichten, die door de melkveehouders in gang waren gezet en die mogelijk het bestaande regime konden veranderen. Tijdens de conflicten die ontstonden binnen het Nutriënten Management Project ging het over epistemologische vraagstukken. De verhaallijnen die zich steeds meer hadden geconsolideerd, waren samengesteld op basis van kennis die voor de wetenschap een uitdaging vormde; zowel in de zin van 'welke kennis' (zaken als grond en additieven) en in de zin van 'hoe verkrijgt men die kennis' (kennis afkomstig van melkveehouders staat gelijk aan wetenschappelijke kennis). De verhaallijn over goede mest gaf aan via welke manier van bedrijfsvoering men de mestcrisis kon tegengaan. De verhaallijn vertelt dat een combinatie van maatregelen zoals bodembeheer, andere vormen van voeding (met meer ruwe celstof en minder eiwit) en het gebruik van additieven, evenals het zorgvuldig aanwenden van mest via bovengronds uitrijden voldoende zijn om de milieuproblemen op bedrijfsniveau op te lossen. Het bodem-plant-dier systeem werd een gemeenschappelijke verhaallijn over het kijken naar het bedrijf vanuit een systeem benadering. Het is een verhaallijn verpakt als een schematische voorstelling die buiten het experiment van het Nutriënten Management Project kon worden doorverteld. Als metafoor voor het bestaande regime ontstond het David tegen Goliath verhaal, waarin de melkveehouders en de wetenschappers zelf een actieve rol speelden in het veranderen van het regime door het actief promoten van het maken van goede mest evenals het promoten van de systeem benadering.

Hoofdstuk 5 laat zien hoe acht melkveehouders veranderingen hebben aangebracht in hun nutriënten management. Zij streefden ernaar om goede mest te maken en hebben daar hun manieren van bedrijfsvoering aan aangepast. Bodem, plant en dier komen weer in evenwicht wanneer de kwaliteit van de mest en de manieren van toepassen van mest worden verbeterd. Omdat het maken van goede mest integraal onderdeel uitmaakt van de algemene bedrijfsvoering van een agrarische onderneming en er verschillende manieren zijn om goede mest te maken leidt dit tot verschillende opties voor nutriënten management voor de verschillende melkveehouders, waardoor er een grote verscheidenheid aan melkveebedrijven ontstaat. De boeren ontwikkelen nieuwe inzichten in het specifieke karakter van hun eigen bodem-plant-dier systeem en de dynamische verbanden met de plaatselijke omstandigheden en de voorhanden zijnde groeifactoren. Voor de melkveehouders hadden indicatoren verschillende functies. In de eerste plaats kan een melkveehouder aan de hand van de indicatoren vaststellen of hij zijn bedrijfsdoelstellingen op de juiste manier heeft behaald. De tweede functie van indicatoren houdt in dat zij dienen als epistemologisch middel om de verhaallijn over goede mest kracht bij te zetten. Bij het maken van goede mest werden de melkveehouders geconfronteerd met verschillende technologische en institutionele beperkingen. Om de verhaallijn over goede mest volledig te laten ontwikkelen op bedrijfsniveau, zullen er ook technologische en institutionele aanpassingen binnen het heersende regime moeten worden aangebracht.

Hoofdstuk 6 gaat over de vertellers van de verhaallijn over goede mest en over hun streven naar het opzetten van een nieuwe niche waar de melkveehouders meer institutionele ruimte zouden moeten krijgen om goede mest te maken door het bedrijf als een systeem te benaderen. De verhaallijn over goede mest werd verteld in verschillende settings, bijvoorbeeld aan wetenschappers, aan melkveehouders onderling, tijdens besprekingen tussen melkveehouders en vertegenwoordigers van de ministeries en in rechtszaken. Binnen de wetenschap werden er bewijzen verzameld zodat wetenschappers en de overheid de claims aannemelijk zouden vinden. Binnen de agrarische bedrijven werd de verhaallijn over goede mest concreet vertaald naar nieuwe manieren van bedrijfsvoering die door de melkveehouders konden worden ingevoerd.

Volgens de vertellers zou er voor melkveehouders die goede mest maken meer ruimte moeten zijn binnen de regelgeving en de politiek. Er zou meer ruimte moeten zijn voor de melkveehouders om de eigen werkwijze te volgen en bovengronds uitrijden zou vanwege deze reden legaal moeten worden.

In de loop der tijd werd het verhaal dat er meerdere manieren zijn om goede mest te maken meer en meer geaccepteerd. Een voorbeeld hiervan is de integratie van plaatselijke verschillen in de wet op de excretie normen. De verhaallijnen die waren ontstaan binnen het VEL en VANLA project leidden tot nieuwe onderzoeksprojecten, bijvoorbeeld het onderzoek dat werd uitgevoerd op het bedrijf melkveehouder Spruit en in het Friese Wouden project. Toch leidde het geheel aan kennis dat uit de verhaallijnen voortvloeide niet tot een aanpassing van het mestbeleid op het gebied van mest-aanwendingstechnieken. Binnen de wetenschap zijn er nog steeds twijfels over de claims. Het blijft de vraag of er voldoende bewijzen en kennis zijn vergaard binnen het Nutriënten Management Project van VEL en VANLA om 'anderen' binnen het groeiende netwerk ervan te overtuigen dat het mestbeleid dient te worden aangepast. Er bestond ook een wisselwerking tussen de verhaallijn over goede mest en andere projecten voor nutriënten management die tegelijkertijd werden opgezet. De systeembenadering werd ook binnen deze nutriënten management projecten onderzocht en ontwikkeld. Er werden nieuwe initiatieven ontwikkeld, waarbij melkveehouders gezamenlijk experimenten uitvoerden met nieuwe vormen van nutriënten management die ook gericht waren op een radicale verandering van het bestaande regime. Weer andere projecten gingen ook aan de slag met de systeembenadering en pasten het aan hun eigen doelstellingen aan. Het Nutriënten Management Project van VEL en VANLA groeide uit tot twee nieuwe projecten. De vraag is of nieuwe actoren binnen het netwerk dezelfde visie op innovatie en verandering van regime hebben als de visie die aanvankelijk in de verhaallijn over goede mest werd doorgegeven.

Hoofdstuk 7 behandelt twee casussen waarin actoren, die nieuwe vormen van bedrijfsvoering ontwikkelden, bij elkaar kwamen om zich bezig te houden met de vraag 'wat is valide kennis' binnen nutriënten management en de vraag wat dit betekent voor het opzetten van onderzoeksprojecten binnen de landbouwwetenschappen en de ontwikkeling van bemestingsadviezen. De twee projecten zijn zelf een voorbeeld van onderzoeksexperimenten binnen de landbouwwetenschappen. In de eerste casus zeiden de betrokkenen dat onderzoeksprojecten gebruik zouden moeten maken van de kennis van de melkveehouders en dat ze zich actief zouden moeten richten op de ontwikkeling van nieuwe methoden voor het maken van goede mest. Ze waren sterk voor het uitbreiden van kennisproductie naar andere domeinen dan de wetenschap alleen. Volgens hen zouden adviessystemen meer gericht moeten zijn op het uitbreiden van de deskundigheid van melkveehouders binnen het eigen bedrijf of de eigen regio. Ze zeiden dat er meer nadruk moest worden gelegd op het uitwisselen en verspreiden van kennis afkomstig van diverse bronnen. De onderzoeksprojecten zouden deze kennis gelijk moeten stellen aan kennis afkomstig van laboratoria en experimenten. In de tweede casus ging het om de verschillende meningen betreffende de vraag 'wat is valide kennis' bij het ontwikkelen van adviezen. De betrokkenen waren het eens dat melkveehouders meer invloed zouden moeten hebben op de inhoud van het advies, bijvoorbeeld door nieuwe onderzoeksonderwerpen aan te snijden (zoals mest en bodem) en door kritiek te leveren op de lokale toepasbaarheid van adviezen bij besluiten omtrent de bedrijfsvoering. De actoren stelden voor om regionale groepen te stimuleren of zelfs actief te ondersteunen bij het ontwikkelen van hun eigen regiogebonden adviezen of bij het leveren van andere bijdragen aan de adviezen. In beide gevallen wezen de actoren op de gevolgen van het integreren van nieuwe manier van kennisproductie in het opzetten van onderzoeksprojecten en adviezen. Ten eerste dient het ontwikkelen van kennis in de openbaarheid te worden gebracht en het dient transparant te worden gemaakt, zodat anderen er zelf over kunnen oordelen. Ten tweede dient het proces van het vertalen van algemene kennis naar plaatsgebonden kennis voor specifieke doelgroepen, en omgekeerd, deel uit te maken van het de manier waarop wetenschappelijke onderzoek wordt gedaan. Ten derde dienen melkveehouders deze nieuwe bronnen van kennis aan te passen aan hun besluiten over de bedrijfsvoering en zij dienen te leren omgaan met deze nieuwe vormen van informatie.

Conclusies

Binnen het Nutriënten Management Project van VEL en VANLA zijn drie verhaallijnen ontstaan. Er werd niet alleen gezocht naar nieuwe manieren van bedrijfsvoering met betrekking tot het omgaan met mest (aangegeven als de verhaallijn over goede mest), maar ze experimenteerden ook met nieuwe opties voor de manier waarop landbouwkundig onderzoek wordt gedaan (omschreven als de verhaallijn over het benaderen van het bedrijf als een systeem). De vertellers van de verhaallijnen vonden elkaar in de David tegen Goliath verhaallijn, waarin de actoren op radicale wijze het bestaande regime willen veranderen.

Deze drie verhaallijnen ontwikkelden zich verder en zorgden niet alleen voor onderlinge coherentie binnen het project, maar zorgen er ook voor dat de meeste actoren binnen het Nutriënten Management Project van VEL en VANLA een gemeenschappelijke betekenis aan hun werkzaamheden konden geven. In de loop der tijd breidde het dragende netwerk van de verhaallijnen van VEL and VANLA zich uit. De verhaallijnen, inclusief de diverse artefacten en inscripties begonnen zich te verspreiden en werden binnen verschillende 'communities of practice' in aangepaste vorm doorverteld. De verhaallijnen consolideerden zich en door hun externe invloed ontstond er een afstemming tussen de actoren die nodig was voor het ontwikkelen van een nieuwe niche die wellicht zou kunnen leiden tot verandering van het regime.

Dit proefschrift geeft aan dat het belangrijk is, of beter gezegd, absoluut noodzakelijk is, dat 'communities of practice', die afwijken van of tegenstrijdig zijn aan de heersende manieren van denken, worden beschermd en gestimuleerd. Dit is zo belangrijk omdat deze communities of practice nieuwe inzichten kunnen bevatten die nu nog verborgen zijn en die kunnen leiden tot een radicale ommezwaai naar maatschappelijk verantwoord ondernemen. De Nederlandse overheid zou bijvoorbeeld de claims en verhaallijnen achter het huidige beleid in heroverweging kunnen nemen en deze kunnen vergelijken met de claims die nu aan het ontstaan zijn en waarin wordt beweerd dat de melkveehouders nu andere, maar even waardevolle, manieren hebben gevonden om aan de eisen van duurzaam ondernemen te voldoen.

De drie verhaallijnen zorgen voor onderlinge afstemming van de actoren die zo een bepaalde betekenis gaven aan de werkzaamheden binnen de experimenten. Door de verhaallijnen hadden de actoren de mogelijkheid om aan te geven wat zij nieuw en innovatief vonden binnen de experimenten. Met andere woorden, de verhaallijnen zorgden voor coherentie binnen de 'community of practice' waar de actoren bij betrokken waren. Bovendien kregen de verhaallijnen externe invloed, namelijk op de innovatieve processen die kunnen leiden tot verandering van het regime. De verhaallijnen werden binnen andere communities of practice als waardevolle kennis beschouwd, bijvoorbeeld in nieuwe experimenten, binnen overheidsinstanties en wetenschappelijke instituten. Verhaallijnen kregen ook externe invloed omdat ze nauw verbonden waren met en concreet werden vastgelegd in de praktijk, bijvoorbeeld in nieuwe mogelijkheden voor het opzetten van een onderzoek, technologieën, nieuwe vormen van bedrijfsvoering, schriftelijk materiaal, schematische voorstellingen en publicaties. Een speciale rol is weggelegd voor de indicatoren; ze fungeren als controle-eenheden bij het streven om de verhaallijn van goede mest toe te passen binnen de bedrijfsvoering; ze dienen als epistemologisch middel om de verhaallijnen tegenover de buitenwereld te bevestigen en te verduidelijken en ze zorgen voor een gemeenschappelijk perspectief binnen de diverse 'communities of practice'.

Het laatste punt gaat over de veranderende rol van wetenschappers in kennisproductie processen die zich kenmerken door toenemende heterogeniteit. Ten eerste zullen zij conflictsituaties en afstemmingsprocessen als waardevolle bronnen van kennis moeten gaan zien. Ten tweede kunnen wetenschappers die experimenteren met nieuwe vormen van kennisproductie op zoek gaan naar nieuwe locaties of omgevingen om hun onderzoek uit te voeren en zo een basis voor verschillende vormen van kennis ontwikkelen die op hun beurt bijdragen aan de ontwikkeling van nieuwe manieren van bedrijfsvoering. Ten derde zullen de wetenschappers ook fungeren als grenswerkers tussen de wetenschap en de praktijk, bij het ontdekken van plaatsgebonden hypotheses en bij het ontwikkelen van mogelijk vernieuwende manieren van bedrijfsvoering. In hun hoedanigheid als grenswerker kunnen wetenschappers verschillende competenties ontwikkelen. Ten vierde dient er (meer) geld te gaan naar projecten en instellingen die zich richten op de ontwikkeling van diverse vormen van heterogene kennisproductie. Het is van belang dat men bij het opzetten van deze projecten rekening houdt met de verschillende meningen die stakeholders hebben ten aanzien van de maatschappelijke relevantie van onderzoek en dat men verantwoording aflegt tegenover deze stakeholders.

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Appendix 1. Interviews and meetings

Chapter 4 and chapter 6

29-07-99	Study meeting manure and soil, Nutrient Management Project VEL and VANLA
08-09-99	Interview with scientist Van der Ploeg
14-09-99	Interview with farmer Hoeksma
14-09-99	Study meeting cow nutrition, Nutrient Management Project VEL and VANLA
05-10-99	Study meeting cow nutrition, Nutrient Management Project VEL and VANLA
05-10-99	Interview with scientist Van Bruchem
12-10-99	Interview with scientist Van Bruchem
12-10-99	Presentation scientist Van Bruchem to a delegation of Dutch Parliament
13-10-99	Study meeting cow nutrition, Nutrient Management Project VEL and VANLA
14-10-99	Study meeting cow nutrition, Nutrient Management Project VEL and VANLA
16-10-99	Interview with *Landschapsbeheer Friesland* (Friesland Countryside Association)
18-10-99	Meeting environmental cooperative Vanla
08-11-99	Meeting research council, Nutrient Management Project VEL and VANLA
19-11-99	Interview with Van der Ploeg and Verhoeven
22-11-99	Farm visits with consultant Hiemstra to farmer Luimstra and farmer Benedictus
13-12-99	Meeting research council, Nutrient Management Project VEL and VANLA
20-12-99	Meeting research council, Nutrient Management Project VEL and VANLA
xx-02-00	Meeting research council, Nutrient Management Project VEL and VANLA
xx-02-00	Presentation of VEL and VANLA to a delegation of the Dutch Parliament
17-02-00	Study meeting manure, Nutrient Management Project VEL and VANLA
xx-05-00	Internship at farm of Van Tilburg
xx-06-00	Internship at farm of Benedictus
xx-06-00	Meeting research council, Nutrient Management Project VEL and VANLA
xx-07-00	Study meeting on the soil, Nutrient Management Project VEL and VANLA
xx-11-00	Interview with scientist Roep
20-12-01	Meeting research council, Nutrient Management Project VEL and VANLA
04-07-02	Meeting research council, Nutrient Management Project VEL and VANLA
13-03-02	Interview with scientist Reijs
14-03-02	Interview with scientist Reijs and farmer Boersma
16-03-02	Interview with scientist Van der Ploeg
20-03-02	Study meeting scientist Reijs, Nutrient Management Project VEL and VANLA
17-06-02	Meeting research council, Nutrient Management Project VEL and VANLA
15-08-02	Interview with project leader Verhoeven
04-11-02	Interview with farmer Hoeksma
xx-12-02	Meeting research council, Nutrient Management Project VEL and VANLA
09-01-03	Meeting research council, Nutrient Management Project VEL and VANLA

29-04-03	Evaluation Nutrient Management Project VEL and VANLA
04-06-03	Interview with scientist Reijs
06-11-03	Workshop Project *Slim Experimenteren*
14-07-07	Correspondence with scientist Schröder
16-07-07	Correspondence with scientist Schröder
17-07-07	Interview with scientist Van Bruchem
18-07-07	Interview with scientist Van der Ploeg
23-07-07	Interview with project leader Verhoeven
28-07-07	Interview with project leader Verhoeven
31-08-07	Interview with scientist Galama
31-08-07	Interview with farmer Bloemhof
31-08-07	Interview with farmer Timmerman
21-11-07	Study meeting scientist Reijs, Nutrient Management Project VEL and VANLA

Chapter 5

09-11-00	Interview with farmer Oosterhof
09-11-00	Interview with farmer Kremer
09-11-00	Interview with farmer Scholten
10-11-00	Interview with farmer Boersma
10-11-00	Interview with farmer Timmerman
10-11-00	Interview with farmer Berkhof
11-11-00	Interview with farmer Douma
11-11-00	Interview with farmer Bloemhof
xx-06-02	Interview with farmer Kremer
xx-06-02	Interview with farmer Scholten
xx-06-02	Interview with farmer Douma
xx-06-02	Interview with farmer Oosterhof
xx-03-03	Interview with farmer Bloemhof
xx-03-03	Interview with farmer Berkhof
xx-03-03	Interview with farmer Timmerman
xx-03-03	Interview with farmer Boersma

Chapter 7

xx-11-01	Meeting Experiential Knowledge Working Group
20-03-02	Workshop Experiential Knowledge Working Group
19-06-02	Meeting Manure Application Advice
14-01-03	Workshop I Manure Application Advice
xx-06-03	Workshop II Manure Application Advice

Appendix 2. List of terms and abbreviations

% protein/milk	percentage protein in the milk
Agrinovim	the dynamics of AGRicultural Innovation: studies at the interface of NOVelty creation and sociotechnical regimes; acronym for NWO programme; 'Towards new technico-institutional design methods: the integrated down-scaling of agricultural processes of production to new levels of sustainability'
APC	Agricultural Policy Community
APM	A.P. *Minderhoudhoeve*, experimental farm in Swifterbant
Bioveem	Nutrient Management Project focused on organic farming, in cooperation with DLV, LBI and Animal Sciences Group of Wageningen UR
CLM	CLM Research and Advice (in Dutch: *Centrum voor Landbouw en Milieu*)
C/N	indicates the amount of carbon relative to the amount of nitrogen present
De Marke	experimental farm in Hengelo, The Netherlands
DLG	Government Service for Land and Water Use (in Dutch: *Dienst Landelijk Gebied*)
DLV	consultancy focused on service for the Agricultural sector in the Netherlands
EM	Effective Microbes (in Dutch: *Effectieve Micro-organismen*); a mixture of microbes that is supposed to increase the microbe activity in manure, soil and plant (Higa 1998)
Euromanure mixture	(in Dutch: *Euromestmix*) a composition of clay minerals
Kg milk/cow	milk production in kilograms per cow
Koeien en Kansen	Nutrient Management Project of 16 dairy farmers, De Marke and Wageningen UR
LBI	*Louis Bolk Instituut*, research centre for organic agriculture at Driebergen, The Netherlands
LNV	Ministry of Agriculture, Nature and Food Quality (in Dutch: *Ministerie van Landbouw, Natuur en Voedselkwaliteit*)
LTO	Dutch Farmers Organisation (in Dutch: *Land- en Tuinbouw Organisatie*)
NLTO	the Northern Branch of the Dutch Farmers Organisation (in Dutch: *Noordelijke Land- en Tuinbouw Organisatie*)
NLV	Nitrogen Delivery Capacity (in Dutch: *stikstof leverend vermogen*)
N efficiency	nitrogen efficiency (in Dutch: *stikstof efficiëntie*)
Nmin	mineral Nitrogen (in Dutch: *minerale stikstof*)
NRLO	Dutch National Council for Scientific Research (in Dutch: *Nationale Raad voor Landbouwkundig Onderzoek*)
Norg	organic Nitrogen (in Dutch: *organische stikstof*)

Ntotal	total Nitrogen (in Dutch: *totale stikstof*)
NWO	Dutch organisation for scientific research (in Dutch: *Nederlandse Organisatie voor Wetenschappelijk Onderzoek)*
OEB	surplus of protein in the ration (in Dutch: *Onbestendige Eiwit Balans*)
PMOV	*Platform Minderhoudhoeve, Ossekampen, VEL en VANLA*; organisation of farmers and research stations to enhance innovation in dairy farming
PRI	Plant Research International
Praktijkcijfers	Nutrient Management Project with 375 farmers, in cooperation with LNV, VROM and LTO
RE	crude protein (in Dutch: *ruw eiwit*)
VANLA	V*ereniging Agrarisch Natuur- en Landschapsbeheer Achtkarspelen*
VEM	energy content in the silage (in Dutch: *Voeder Eenheid Melk*)
VEL	*Vereniging Eastermar's Lansdouwe*
VROM	Ministry of Housing, Spatial Planning and the Environment (in Dutch: *Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer*)
Wageningen UR	Wageningen University and Research Centre (in Dutch: *Wageningen Universiteit en Research Centrum*)
WRR	Netherlands Scientific Council for Government Policy (in Dutch: *Wetenschappelijke Raad voor het Regeringsbeleid*)

Appendix 3. Anonymity respondents

The following names of respondents are invented to respect the anonymity of the source.

Farmer Berkhof
Farmer Houtstra
Farmer Diekstra
Consultant Troost
Consultant Wiegers
Consultant de Rijk

The following respondents have given permission to use their statements from meetings and interviews:

Scientist van Bruchem
Scientist Schils
Scientist Verhoeven
Scientist Van der Ploeg
Scientist Schröder
Scientist Galama
Scientist Baars
Farmer Hoeksma
Farmer Bloemhof
Farmer Boersma
Farmer Douma
Farmer Scholten
Farmer Timmerman
Farmer Kremer
Farmer Oosterhof

Acknowledgements (in Dutch)

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Curriculum Vitae

Marian Stuiver werd op 29 augustus 1971 geboren te Nunspeet.
Na het behalen van het VWO diploma aan het Lambert Franckens College te Elburg begon zij in 1989 met rurale ontwikkelingsstudies aan de Landbouw Universiteit in Wageningen. Een eerste afstudeer-onderzoek richtte zich op de landhervorming in postcommunistisch Roemenie. Een volgend afstudeer-onderzoek voor de Land- en Tuinbouw Organisatie betrof een inventarisatie van de toekomstperspectieven van varkenshouders in de provincie Gelderland. Als laatste afstudeeronderzoek deed zij een theoretische studie naar het debat over de milieucrisis. In 1999 sloot zij haar studie cum laude af met als specialisatie rurale sociologie.
In hetzelfde jaar trad zij in dienst als onderzoeker in opleiding bij de leerstoelgroep Rurale Sociologie. Daarnaast was zij in 2000 werkzaam als lid van de TaskForce Waardevolle Landbouw in opdracht van het College van Bestuur van Wageningen Universiteit en Research Centrum.
Ook was zij in Wageningen gemeenteraadslid voor GroenLinks in de periode 2002 tot 2006.
In maart 2006 trad zij in dienst als projectregisseur wetenschap bij TransForum Agro en Groen te Zoetermeer. Sinds 2008 werkt zij als postdoc aan de Universiteit van Amsterdam binnen het NWO programma Omstreden Democratie aan een onderzoek naar protesten tegen telefoonmasten en het ontstaan van politieke identiteiten.

1. In maatschappelijke veranderingsprocessen kunnen krachtige verhaallijnen aanwezig zijn (dit proefschrift).

2. De Nederlandse melkveehouderij kent niet één goede landbouwpraktijk maar meerdere ontwikkelende goede landbouwpraktijken (dit proefschrift).

3. Formalisering van boerenkennis maakt nieuwe actoren zichtbaar.

4. Organisaties die streven naar een verduurzaming van de landbouw kunnen hun besteding van overheidsgelden alleen verantwoorden, als ze samen werken met actoren die het landbouwregime radicaal willen verduurzamen.

5. De kennis die de laatste jaren is ontwikkeld over het bovengronds uitrijden van goede mest maakt een heroverweging van de wet, die verplicht dat drijfmest in de bodem wordt geïnjecteerd, noodzakelijk.

6. Deskundigheid betreffende de dynamiek van duurzame lokale initiatieven en deskundigheid betreffende globalisering zijn beide van groot belang. Maar er is vooral behoefte aan ondernemers die verbanden tussen beide leggen en daarop actie ondernemen.

Stellingen behorend bij het proefschrift:
Regime Change and Storylines, a sociological analysis of manure practices in contemporary Dutch dairy farming, door Marian Stuiver, in het openbaar te verdedigen op vrijdag 29 februari 2008 om 16.00 in de Aula van Wageningen Universiteit en Research Centrum