The VEL and VANLA environmental co-operatives as field laboratories

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Received 10 February 2003; accepted 24 May 2003

Abstract

This article describes the Nutrient Management Project of the environmental co-operatives VEL and VANLA as a field laboratory. A field laboratory is defined as a heterogeneous collection of inter-linked scientific studies performed by several actors within a specific field, but – as in normal laboratories – with some protection against outside interference and disturbance. The Nutrient Management Project of VEL and VANLA demonstrates several characteristics of field laboratories. Firstly, in the project, dairy farmers and scientists carry out joint research using different sources of knowledge. Secondly, apart from research the actors are engaged in changing the location, thereby developing new knowledge and practices. In the case of VEL and VANLA this means developing the fields and farms towards sustainability. Thirdly, the actors thoughtfully experiment with several research methodologies to gain understanding on a variety of issues. So within the field laboratory of VEL and VANLA there is heterogeneity in themes, disciplines and methodologies. Simultaneously a systems perspective is created as an interpretative scheme that links up all the different activities. Finally, within VEL and VANLA, alignment among practices, research and the institutional context is essential for the continuation of the research activities.

Additional keywords: farmers' knowledge, scientific methodologies, nutrient management, dairy farming, multi-functional agriculture

Introduction

Since 1998, the joint research activities of farmers and scientists within the environmental co-operatives *Vereniging Eastermar's Lânsdouwe* (VEL) and *Vereniging Agrarisch Natuur en Landschapsbeheer Achtkarspelen* (VANLA) have been bundled in the so-called Nutrient Management Project. The project's central question is how to increase nitrogen efficiency in dairy farming systems with the objective to decrease – in a cost-effective way – the surplus of nitrogen emitted in nitrate and ammonia. So the aim of the project has become twofold. Firstly, the dairy farming systems are deliberately subject of change. Secondly, these changes are monitored and analysed by the scientists and dairy farmers involved.

The project consists of two components. The first component is the interaction between scientists and dairy farmers. Among each other and within their own communities they discuss their observations and analyses (Figure 1). The second component is that the research activities – for a large part deliberately – are performed on location, that is, in the fields and on the farms of the dairy farmers involved.

In this article we describe the Nutrient Management Project of VEL and VANLA within the concept of field laboratories. First a definition is given of field laboratories by comparing them with normal laboratories. Next we will analyse several experiences of the VEL and VANLA project as essential characteristics of a field laboratory. Finally, we highlight some of the implications that field laboratories like the VEL & VANLA Nutrient Management Project can have for the development of agricultural sciences.

A definition of field laboratories

Field laboratories can be defined as a heterogeneous collection of inter-linked scientific studies performed by different actors within one specific field. In order to deepen the concept of field laboratory we first consider the concept laboratory and subsequently connect it with the concept field. Both concepts are relevant for constituting the term field laboratory.

Laboratory experiments always have played an essential role in (agricultural) sciences. Knowledge generated in laboratories is the outcome of (experimental) find-

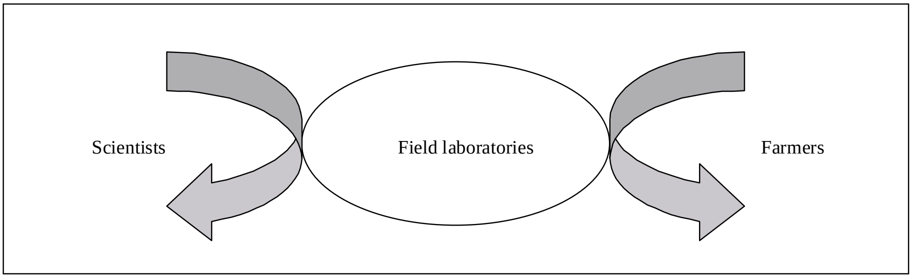

Figure 1. Field laboratories as interaction between farmers and scientists.

ings 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, the manipulation of a selected group of variables will give precise insights into the effects of this manipulation. Thus, specific cause-effect relations can be identified. It is assumed that the relationships found also apply at other times and places.

Generating scientific knowledge is paramount in field laboratories too. Also within field laboratories there is a certain kind of control and protection of the research site. But there are also differences with normal laboratories. The research performed in field laboratories is taking place within real life practices, *in situ* instead of *ex situ*. In other words, field laboratories are consciously designed at a certain location with its specific circumstances. The boundaries of field laboratories are therefore different from, and not as strict as the boundaries of normal laboratories.

Experimentation within normal laboratory settings is primarily the domain of scientists. The influence of lay people on the research agenda in such laboratories is minimal. On the other hand, field laboratories are places where actors do research together. Also within other scientific projects, examples of joint research have come to the fore (for an overview see Baars, 2002). Laymen's knowledge becomes more important within the research. Different actors are providing different sources of knowledge. Other important sources of knowledge might be mobilized as well, such as experiential and empirical knowledge.

The VEL & VANLA Nutrient Management Project as a new framework for knowledge production

Introduction

VEL and VANLA are among the first environmental co-operatives in the Netherlands. An environmental co-operative is a regional co-operation of mostly agricultural entrepreneurs who aim to integrate environment, nature and landscape objectives into their farming practices. VEL and VANLA are located in the Frisian Woodlands, an area of 12,500 ha of land. The Frisian Woodlands form a combination of small-scale and closed landscapes on the higher sandy soils alternated by relatively open areas on the lower peat-clay soils. The small-scale landscapes are formed by hedges and belts of alder trees surrounding the plots of land, resulting in a unique mosaic of parcels.

The main reason for establishing the VEL and VANLA co-operatives is explained by Renting (1995): "*The new rules for sustainability were seen as difficult to implement, poorly balanced and contradicting each other. This was one of the reasons to set up the environmental co-operatives.*" Some of the dairy farmers in the area were extremely worried, wondering whether they could keep small-scale farming viable. Environmental policies seemed to disrupt the local ways of farming and create contradictions between farming and maintaining nature and landscape. The dairy farmers feared a nearly complete standstill of farming in the area (Renting & Van Der Ploeg, 2001). The environmental co-operative was seen as a means to overcome contradictions between farming and maintaining nature and landscape and simultaneously create new and economically viable perspectives for dairy farming: "*The environmental co-operatives see the governance of nature, landscape and environment as their responsibility. They can fulfil their governance tasks by negotiating with the land users and by co-ordinating the activities that need to be done. In that way external control by government organizations or nature organizations can be limited to formulating clear aims. The methods of how to deal with nature, landscape and environment can better be left to the farmers.*" (Renting & De Bruin, 1992).

The dairy farmers founded the environmental co-operatives in 1992 in close co-operation with scientists from Wageningen University and Research Centre. At that time scientists had done research on diversity in farming styles and on novelties developed in the area (Van Der Ploeg, 1999). But these novelties had not been recognized outside the area, and in that sense remained hidden (Stuiver & Wiskerke, 2003). In collaboration with farmers, scientists made the hidden novelties explicit, and recognized them as socio-technical configurations (Wiskerke, 2003) that looked promising as possible new roads to sustainability.

A first example of a hidden novelty was that some farmers had grasslands that appeared to continuously produce high yields with little inorganic fertilizer. The farmers' hypothesis was that these pastures performed so well because they were 'old pastures' in the sense that they had not been ploughed for several years. The soils of these grasslands had a high organic matter content and the swards consisted of diverse types of grasses. The grasslands provided types of grass silage that improved the ways in which the dairy cattle digested the feed. This in turn led to another type of manure that would better maintain soil fertility and in that way would improve grassland production. A second example of a hidden novelty was that some farmers started to use additives to their slurry manure that were claimed to considerably reduce ammonia emission. A third example was the successful experience farmers had with the integration of landscape in their farming practices.

Recognizing such practices as interesting, a scientific research project was started to further develop these novelties and at the same time study them. The Nutrient Management Project started in 1998. The central question was how to increase nitrogen use efficiency in the total farming system in order to reduce ammonia volatilization and nitrate leaching. This might – according to the participants of the co-operatives – very well be compatible with the particular landscape in the area and the natural resources present.

At the same time the identified novelties evoked questions with the scientific community. A group of scientists from Wageningen University did not appreciate the – in their eyes – dominant assumption that in order to increase nitrogen use efficiency, one has to improve the performance and functioning of the animal. Challenging this hypothesis, two animal scientists drew up the nitrogen balances of a number of VEL and VANLA farms. From these balances it became evident that there were huge differences in nitrogen losses among farms. So the scientists wanted to have a better understanding of the farms with high nitrogen use efficiency. Moreover, nitrogen use efficiency in the soil-plant system among farms varied more than efficiency of nitrogen use by the animal. This observation suggested that there was more to gain from

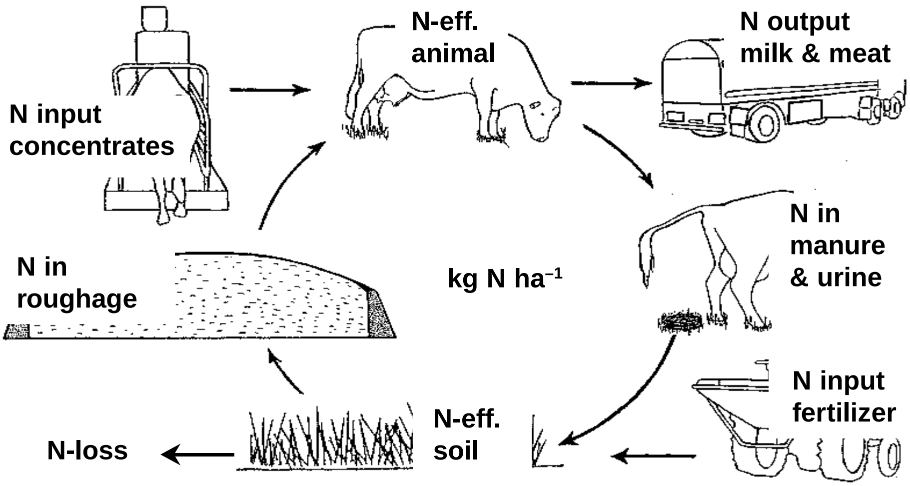

Figure 2. The systems perspective of the VEL & VANLA Nutrient Management Project.

increasing nitrogen use efficiency in the soil-plant system than in the animal (Verhoeven & Van Der Made, 1998). These findings thus confirmed the farmers' practices described above.

Creating a systems perspective

Figure 2 illustrates the overall thinking within the Nutrient Management Project and shows the activities and ideas that are being developed. In short, it depicts the soil-plant-animal system interactions, a pattern of linkages that represent the nitrogen flows within a farm (Verhoeven *et al.*, 2003) and offers the possibility to improve nitrogen efficiency at farm level. The idea is that in order to increase nitrogen use efficiency the farmer not only has to improve the use of nitrogen within the different subsystems but also the relations between these subsystems. "*In Wageningen we thought for a long time that we could solve our environmental problems by improving parts of the farming system, like the cow. Now we know better. We have to think more in improving systems.*" (Koopman, 1998). The systems perspective encompasses the idea that dairy farming can be carried out in a more sustainable way by fine-tuning the subsystems of soil, plant and animal and by making better use of local resources available in the system. "*What is required is a systematic and integral re-organization of the production process in order to create a new balance that allows for farming being both ecologically and economically sustainable. All relevant subsystems need to be reorganized in such a way that a new equilibrium is created.*" (Van Bruchem & Tamminga, 1997).

The systems perspective became the framework for the joint activities between farmers and scientists within the project. Over the years they developed a framework elucidating nutrient flows in the soil-plant-animal system on dairy farms. The interaction between the different actors involved was crucial. For instance, in order to under-

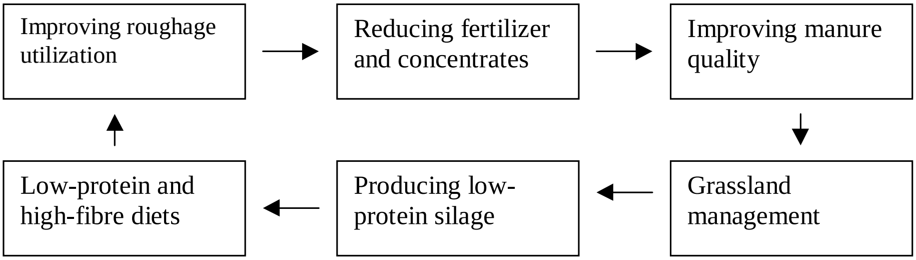

Figure 3. Measures with which the farmers experiment.

stand nitrogen use efficiency in the soil, farmers and scientists had to provide knowledge and experiences. The framework was discussed intensively among them. During these discussions the interpretation of the framework and a shared understanding of the hypothesis to be investigated were constructed. Through interaction they learned about the farming styles, the goals of the individual farmer, and the particularities of the farm. Farmers and scientists created understanding about the background of the data in the framework. They came to understand the size of the nutrient flows on the farm, and how the farmer managed these flows. The farmers involved in the project collected data of their farms, which scientists used to parameterize the soil-plant-animal system of each farm.

The farmers furthermore contributed to the development of the systems perspective by changing their practices and reflecting on these changes. The scientists formulated a series of measures that could serve as adaptations within the farming system. The most important measures are shown in Figure 3. It is important to note here that the adaptations or 'measures' of Figure 3 are not prescriptions; they are recommended roads for on-farm trials. The degree and the way in which these measures are useful differ from farm to farm.

The implementation of these adaptations resulted in 60 experimental farms differing in measures, goals and experiences. Farmers and scientists used this variation to learn from. For example, farmers compared fields where inorganic fertilizer had been applied with another field without inorganic fertilizer. Or they compared growth differences in grass between soils with a high and soils with a low percentage of soil organic matter. Instead of learning from universally valid formulas and models or from averages, they learned by comparing specific situations. As one farmer commented: "*Every cow reacts differently to a new way of nutrient supply, with different outcomes in health, milk production and meat production. I adjust the fodder intake to these diverse reactions of the cows, but also to the available fodder, which changes with the seasons and with the harvest of grass, maize or other crops.*"

Research activities within VEL and VANLA

Within the project, farmers and scientists learn about the ins and outs of soil-plant-animal system interactions and the required complementary socio-technologies and infrastructures. For researchers of Wageningen University the Nutrient Management Project of VEL and VANLA has become a major challenge. The scientists become engaged in new lines of research, some of which might very well turn out to be highly innovative, also in academic respect.

New lines of research are for example those in soil science where physical soil characteristics are studied as developing into different directions (Sonneveld *et al.*, 2002b). The same holds for aspects of soil biology and agronomy. The interaction between different types of inorganic fertilizer and cattle slurry manure on the one hand, and the 'food webs' in the soil and the associated 'nitrogen delivery capacity' on the other, promise to result in new insights. Animal scientists and agronomists have identified and underlined new ways of looking at the relevance of resources. Examples are the C/N ratio of manure and the indigestible crude protein in grass silage as related to high fertilization levels. The same applies to social scientists. The development and elaboration of farmers' knowledge as well as joint research could be carried out *in situ*.

Different scientists use different experimental methods. An example of this in the project is the establishment of test plots on slurry manure application techniques in two farmers' fields (see Schils & Kok, 2003). Apart from experimentation, also other scientific methods are used. Firstly, soil scientists became engaged in mapping the interactions between farm practices and soil structure in time and space (Sonneveld *et al.*, 2002a). Secondly, in the course of time a database started to take shape that contains all relevant data of the 60 farms. The question as to what data are relevant to collect was discussed among the scientists and farmers. Gradually ideas developed, resulting in a wide and dense account of the dynamics of the farms over time. Thirdly, small group meetings played an important role (Eshuis *et al.*, 2001). In every meeting a specific topic related to nutrient management was discussed that focused on the experiences of the farmers. Every farmer narrated his experiences concerning the topic at hand, thus explicating his knowledge on the subject. One topic of discussion was how much manure and inorganic fertilizer to apply. The main question was whether the quantity of inorganic fertilizer could be lowered without reducing grass yield or milk production. Each farmer described the changes he had implemented and the effects he had observed. Subsequently, the participants discussed what had caused the effects and what could be improved. At the same time they tried to relate their own experiences to those of the other farmers present. Such discussions often evolved around finding out details of measures, their effects and the circumstances.

VEL and VANLA as field laboratories

Introduction

As with normal laboratories, the aim of the Nutrient Management Project of VEL and VANLA is to produce knowledge. The main difference with research performed in conventional laboratories is that knowledge in the project is generated at the farms and in the fields of members of the co-operatives.

The research challenges the academic activities of scientists as well as the dairy farmers' experiences with local practices. So the project can be identified as a field laboratory, a heterogeneous collection of inter-linked scientific studies performed by several actors within one specific field, but with some protection against outside interference and disturbance, as in normal laboratories. The field laboratory of VEL and VANLA shows that research can be carried out not only in conventional laboratories or at experimental stations, but also at farms and in farmers' fields.

The field laboratory of VEL and VANLA is about recognizing patterns in diversity and using this pattern recognition for sustainable development. The research includes observations on various parts of the system, like grass, soil and cows. Several research methodologies are used to construct a systems perspective for sustainable dairy farming. Farmers' knowledge is integrated within this systems perspective, which functions as a framework to link up all the different research practices of the scientists involved.

Within the field laboratory, scientists and farmers are deliberately changing the focus. The scientists have chosen to link up with so-called hidden novelties of farmers; they depart from the idea that these novelties represent a trajectory for sustainable farming that is promising for the future. This has implications for how one views agricultural science.

Building upon novelties in the field

Within the Nutrient Management Project of VEL and VANLA, scientific research becomes involved in developing novelties in the field. The rationality behind this scientific endeavour is a dynamic perspective on agriculture as the result of co-production between man and nature.

Co-production refers to the ongoing encounter and interaction between society and nature and to the mutual transformation of the two within and through this continuous encounter. This implies that the modernistic duality between nature on the one hand and society on the other is a simplification that cannot provide an answer to the dynamic nature of farming. This limitation can be overcome with the term co-production. From the perspective of co-production, resources (fields, cows, manure, plants, local ecological systems, knowledge, routines etc.) are continuously moulded and remoulded by human practices and *vice versa*. Fields for instance are not static units that remain stable over time. As they are worked, cultivated or drained they are continuously changing, not just into one but – at least theoretically – into a wide array of directions. In other words, soils are not timeless genoforms but are evolving into different and often highly contrasting phenoforms (Droogers & Bouma, 1997). The same applies to cattle (Groen *et al.,* 1993; Van Bruchem *et al.*, 1999) and to the human and natural resources involved. This means that we are dealing with a multiple set of emergent and heterogeneous constellations. And together with these moving outcomes of co-production, knowledge is moving as well.

Within the Nutrient Management Project of VEL and VANLA the actors acknowledge that co-production is taking place and that they can actively intervene in this process and hopefully learn from it for establishing sustainable trajectories. As a result, within VEL and VANLA the consciously re-moulding of resources in a particular direction has become one of the central lines of activity (Verhoeven *et al.*, 2003). The farmers and scientists strive to re-mould manure, grasslands, soils, the content and structure of grass silage, the feeding and selection of cattle (and therefore cattle as such) and other things in such a way that a new balance is created on the farms. This new balance promises to result in sharply reduced emissions, in improved incomes and in an increased compatibility with landscape and nature.

Integrating different methodologies within a systems perspective

Knowledge generated in laboratories is the outcome of (experimental) findings under controlled conditions. So in laboratories the variability that might otherwise confuse or hinder aggregation becomes manageable. In this *ceteris paribus* situation, the manipulation of a selected group of variables will give precise insights into the effects of this manipulation. Thus, specific cause-effect relations can be identified. It is assumed that the relationships are also applicable at other times and in other places.

Research in a field laboratory involves many variables. Therefore such research does not focus on single and/or partial cause-effect relations like research in normal laboratories. In VEL and VANLA, scientists and farmers are confronted with a changing and multidimensional context. The farmers try to respond to this by defining and developing a wide range of inter-linked adaptations in farm practice. This changing of context and farm practice implies that simple cause-effect relations are not adequate instruments to induce change in farm management, especially at the beginning of the process. In a real life situation interaction effects at higher levels of aggregation (which might affect the system behaviour of the composing sub-systems) cannot be excluded.

Research in field laboratories focuses on the possibility of fine-tuning an integrated, multidimensional and multi-level system as a whole. The actors try to make an overall system explicit and consequently recognize meaningful patterns within this system. We understand farming as the knowledgeable and active search for and creation of coherence. There is no need to break that down into an endless range of – mostly meaningless and incoherent – constellations like for instance in a laboratory situation. On the contrary, the potentially meaningful patterns of coherence that emerge may very well be analysed in other ways, for instance with multivariate research methods. They allow for the exploration of underlying patterns of coherence, rendering insights that may lead to farm experiments and also set the agenda for academic research.

Within VEL and VANLA the approach of finding cause-effect relations is only one type of research. There is a range of scientific studies that use different research methodologies. However, the central issue is to find patterns for developing ways towards sustainability. The systems perspective as presented in Figure 2 is one example of creating such a coherent pattern. Several methodologies are used to investigate the systems perspective on sustainable dairy farming. Science no longer comes to the forefront as being unified by one singular view or one singular methodology (Pickstone, 2000).

Using farmers' knowledge as a resource

Farmers' knowledge is more and more regarded as a useful source for better understanding how ecosystems can or cannot be transformed, how they can be managed and how social systems can be designed that resemble ecosystems (Toledo, 1990; Hobart, 1993). The debate about farmers' knowledge is part of the changing role and contents of science (Scoones & Thompson, 1994). On the one hand, sociologists have put forward that scientific knowledge is socially constructed in a laboratory or test plot (Knorr-Cetina, 1981; Latour, 1987). On the other hand, 'layman's knowledge' – also referred to as 'indigenous knowledge' or 'experiential knowledge' – gets a more important position in research (Callon, 1999; Baars, 2002; Rip, 2002).

Farmers' knowledge refers to the insights and experiences of a farmer to co-ordinate and to (re-)mould a wide range of socio-technical resources within specific localities and networks towards desired outcomes (e.g. sustainable levels of production). Such experiences and insights allow the farmer to come to grips with known relevant resources and/or to discover new ones. The experiences and insights reflect a dynamic process between knowledge and agricultural practices; it is the continuing identification of unknown and unexplored resources. Within VEL and VANLA the scientists and farmers involved aim to provide more empirical understanding about this process (Stuiver *et al.*, 2003).

In the Nutrient Management Project of VEL and VANLA, scientists concentrate on formulating hypotheses, collecting data and analysing these data together with the farmers. A number of manifestations of farmers' knowledge are important for scientific research. Firstly, the farmer makes decisions to rebalance resources within the production process. These resources (like livestock, grassland, nutrients and water) are evidently interrelated. In order to attain new societal goals, more emphasis is put on internal than on external resources (Figure 3). The farmers focus on improving slurry manure, rather than using inorganic fertilizer. The farmers improve the production of silage from their own farm so that it can replace the concentrates from industry. Local ecological conditions and locally available resources become a source of knowledge to develop sustainable balances. This is in line with the earlier statement that the farmers and the scientists are discovering new forms of co-production between men and nature. In view of this recognition, it is evident that specific, local knowledge regarding the farm and its environment is highly relevant.

Secondly, the resources concerned are embedded in specific social-material localities and networks like markets, government, landscape and technologies. Evidently the farmer develops knowledge of the relations between what happens within and what happens outside his farm. So farmers' knowledge does not merely include technical knowledge, it also refers to the social and the technical surroundings. Farmers not only have knowledge of the techniques and the way these work, but also of the way these techniques can be aligned in the social-material environment in which they are placed.

The actors need to make sure that the research activities can take place. They need to develop skills for alignment between practices, research and institutional context. For instance, it takes much effort from the farmers and scientists involved to explain time and again that the activities are worthwhile and relevant for the agricultural sciences. The negotiations with the government for permission to surface-apply slurry manure is an example of this. The hypothesis is that surface application of the slurry manure in combination with additives has advantages for the management of the soil. Surface application is forbidden in the Netherlands but the farmers argue they need to do it for scientific reasons. So every year both farmers and scientists need to negotiate with the government for permission. They actively have to engage in building networks of trust.

Conclusions

The scientific activities within the field laboratory of VEL and VANLA are performed to support new socio-technical trajectories towards sustainable agriculture. Scientists and farmers are actively engaged in developing dairy farming systems, practices and necessary technologies. To do successful research in the field laboratory of VEL and VANLA scientists have developed different skills and knowledge. It is not enough to have knowledge on mono-disciplinary issues, or to develop technical knowledge only. One needs to gain knowledge on multiple issues and at multiple levels. The actors involved have to learn how to do joint research with each other. The scientists need different types of knowledge as a resource, for instance farmers' knowledge. They learn how to compare findings from different sources and scientific disciplines. They need to be willing to learn how to learn together as a group and how to deal with contingencies and unexpected outcomes. Working in a team of scientists from different disciplines also implies that the scientists involved need to learn to understand each other's language and interpretations, and value each other's research methodologies. The scientists also became engaged in different research methodologies, in which boundaries between disciplines are becoming less important. Besides, they deal with different audiences when translating their research findings to a wider public. As both scientists and farmers come from different backgrounds and communities, they (have to) learn how to translate the findings into a language that can be understood by their audience. 'Field laboratories' such as VEL and VANLA trigger a growing discussion among scientists, experts and farmers on scientific research methods. Scientists attempt to develop an alternative pathway to deal with sustainable farming. They try to realize sustainability by adapting to the specific local situation and by making use of variation between localities. Add to this that they have to deal with different forms of knowledge and to learn building networks of trust.

Acknowledgements

The authors wish to thank Lijbert Brussaard, Joan Reijs, Arie Rip, Dirk Roep, Frank Verhoeven and Han Wiskerke for commenting on an earlier version of this paper.

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