Revealing different forms of knowledge held by agricultural scientists and farmers in the context of soil protection and management

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Abstract

This paper aims to analyse results from similar studies in England, Switzerland and France which investigated farmer knowledge and understanding of soil and compared it with the scientists' or technical experts' perspective. Qualitative methods were used to examine the nature of knowledge held by farmers and scientists. Different, but complementary, theoretical approaches were employed in the three studies to explain the results. The results show that farmers do possess considerable knowledge about soil although often they have a broad and intuitive working knowledge drawn from experience rather than a detailed understanding. This 'broad' knowledge contrasts with the 'deep' more focused knowledge held scientists. The results also reveal that farmers and scientist have different conceptions of soil, they use different words and language to describe the same features. These quite different outlooks influence their perception of soil fundamentally and lead to different perspectives and approaches. This has to be taken into account when developing implementation methods.

1. INTRODUCTION

There has been extensive research on the technical aspects of soil protection management in the context of soil erosion and diffuse pollution in Europe (Imeson et al. 2005). Invariably the practices proposed by scientists and technicians rely on farmers to implement them, as Doran (2001 p.1) asserts 'the ultimate determinant of soil quality and health is the land manager'. The difficulties in bridging the divide between technical solutions and implementation in the field, or translating science into practice, are well known. Often these difficulties are underpinned by a difference

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in viewpoint or understanding between those developing soil conservation technologies and those being asked to use them.

Many researchers have recognised that different actors in the context of agricultural management will have different perspectives informed by their interests and experiences, and rooted in their own particular worldviews and practices (Fairhead and Scoones 2005). A number of commentators have looked to the duality of scientific and local knowledge (Morgan and Murdoch 2000) to explain these differences while others emphasise the social dimension of knowledge and have framed their research in terms of conflicting life worlds, knowledge cultures and differing conceptions of reality (Weber 1956; Long 1992, Tsouvalis et al 2000). However few have tried to understand the nature of knowledge that different farmers hold about soil and how it compares to that held by the scientific community. With such understanding, communication between the two communities could be more effective and implementation of soil protection improved.

As such, this paper aims to analyse results from similar studies in England, Switzerland and France which investigated farmer knowledge and understanding of soil and compared it with the scientists' or technical experts' perspective. This analysis aims to highlight similarities between the results and discuss their relevance for implementation of soil protection measures.

2. KNOWLEDGE ABOUT SOIL

A growing literature in a number of countries (Romig et al. 1995; Walter et al. 1997; Bruyn and Abbey 2003) appears to demonstrate that farmers have considerable knowledge of their own soil, are able to identify characteristics of soil quality and have developed a rich vocabulary to describe it (van der Ploeg 1989; Liebig and Doran 1999; Romig et al. 1995; Tsouvalis et al. 2000; van Rompaey 2001; Curtis et al. 2003). In Europe farmers tend to regard their own knowledge in managing the environment as very important and often undervalued (Wilson 1997; Harrison et al.1998; Seymour et al.1998). Farmers often dismiss knowledge from scientists as impractical, too focused and having no appreciation of the realities of farming. Conversely scientists often argue that farmers have insufficient understanding of the reasons and techniques for some management solutions and are not equipped with skills necessary to implement the more complex and knowledge demanding practices that policy now requires such as soil conservation, organic farming, conservation tillage, nutrient management (Central Science Laboratory 2004).

These differences have been related to farmers' and scientists' different norms, values and expectations. In the context of soil as Liebeg and Doran (1999) notes every soil's value 'depends upon its user's goals, perspectives and concerns'. Farmers face a range of economic opportunities for investment of labour and capital, of which agriculture is only one and, within agriculture, soil is only one aspect among many. In contrast soil scientists are concerned with one small element of the farmers world – soil.

This apparent difference between scientific and farming communities presents a challenge for those seeking to implement soil protection practices. Understanding how to bridge the gap between farmers' and scientists' perceptions of soil and its management is important to enable effective communication between the two communities. Although there are increasing efforts by the scientific community to consult farmers and understand and utilise their soil knowledge (Doran 2001; Walter et al 1997, Liebeg and Doran 1999), as well as attempts by farmers to become more competent and scientific in their soil management in response to policy demands, our understanding of how to resolve the tensions between these conflicting perspectives is limited.

3. THEORETICAL CONSIDERATIONS

Understanding 'knowledge' in the context of agriculture has challenged many commentators (Thompson and Scoones 1994; Morgan and Murdoch 2000; Tsouvalis et al 2002) and it is not the intention here to discuss this in detail. It is however important to clarify what we understand as knowledge in the context of this research and how this relates to what we call perspective, viewpoint or understanding. Researchers have tried to explain differences between scientists' and farmers', or practitioners' knowledge essentially in two ways, in terms of knowledge forms or types or in terms of the social dimensions of knowledge.

In the first perspective (see case study from England) - two forms of knowledge have been distinguished, scientific knowledge[3] which is understood to be codified, explicit, and objective and tacit knowledge[4] which is implicit, indigenous and context dependent. Whilst the former is seen as being decontextualised and easily transferable, the latter is described as context dependent and difficult to communicate with others than through personal interaction in a context of shared experiences (Morgan and Murdoch 2000). Researchers have tended to emphasise the tensions between the two and the debate about the validity and superiority of these knowledges particularly in terms of achieving sustainable agriculture is well known (Richards 1985; Kloppenburg 1991; Molnar et al 1992). Many consider however that such a dualism is too simplistic and have problematised the divide between these forms of knowledge (Agraval 2002, Dove 2002). Arguably tacit knowledge is not only the preserve of farmers since scientists too develop tacit knowledge and skills within a certain context (see also Fry 2001, case study from Switzerland). Many argued that these two forms of knowledges are not discrete categories but are fundamentally complementary and supplemental to one another (Romig et al. 1995; Walter et al. 1997; Long 1992), and that knowledges from scientific and practical sources can be integrated, merged and blended (Murdoch and Clark 1994; Clarke and Murdoch 1997; Morgan and Murdoch 2000).

The second perspective (see case study from France) looks to the social dimensions of knowledge and the way it is constructed referring to knowledge systems, networks or communities to describe the dynamic networks of actors, processes of negotiation and diverse ways in which knowledge is constructed. As part of this some researchers have sought to understand knowledge in terms of knowledge cultures (Tsouvalis, Morris) or life worlds (Long 1989), where knowledge held is wrapped up in the world of the individual actor and defines their outlook or perspective. In such social perspectives, according to some (Putnam, 1984; Weber 1956), conceptions of a reality depend on activity and social position where each social group qualifies an object using features that are relevant to its own viewpoint.

This research is interested in knowledge in terms of farmer and scientist understanding or views of soil rather than the content of their knowledge. As such the authors understand that knowledge held by farmers and scientists is not tightly bound in predefined notions of scientific and or tacit knowledge but emerges as part of the wider culture, perspective, working practice and language of being a farmer or a scientist.

Whichever conceptual approach is used to theorise different knowledges or views held by the scientific and farming communities, the fact that there are tensions between them is clear. Whilst research has focused on these tensions, very little time has been spent examining how these different knowledges and viewpoints interact.

This paper first aims to examine the nature of knowledge, as theorised above, held by farmers and scientists in the context of soil management and soil protection and then seeks to explore the potential of bridging the tension between the two.

4. THE THREE STUDIES

The aim of this paper is to draw out similarities and differences between research findings from similar projects in three countries. Because of this details of theoretical perspectives and methodological approach, available in respective publications (Ingram 2005; Fry 2001; Mathieu 2004), are not repeated here. On a methodological point the authors understand that scientists and farmers are not homogenous groups of people, that arable farmer in England with >500 acres of cereal differs from a mixed small scale farmer in rural Switzerland. Equally scientists concerned with soil may be specialists linked to experimental farms, geomorphologists concerned with catchment level processes or agronomists interested in crop-soil interactions with regular interaction with farmers in the field. Although the authors accept that the categories ’farmers and ‘scientist’ are very broad, they are interpreted and described differently in each study (i.e. advisor, scientist, researcher), and the results do indicate that actors within groups demonstrate a similar approach and understandings.

4. ENGLAND

4.1 Context

The aim of the research in England was to gain an understanding of the nature and extent of knowledge held by farmers about soil and its management in the context of projects enhancing soil protection. For further details see Ingram (2005).

4.2 Methodology

Qualitative data was derived from semi- structured interviews with a range of farmers and advisors involved in two soil management initiatives[i] in England promoting soil management such as good cultivation practice to improve soil structure. In addition quantitative data from an extensive questionnaire of agricultural advisors was also gathered.

4.3 Results

A number of advisers consider farmers to be technically knowledgeable and as having an understanding of principles that underpin good soil management. As one independent agronomist (A) said *'Most farmers I deal with are aware of good husbandry techniques and go to great lengths to keep soil in good order*'. For them there is clear evidence of good techniques being used:

Sustainable soil management is brought about by increasing our understanding of the soil dynamics and to use techniques that maintain/enhance the delicate balances as far as possible in the soil, this I would suggest has been practised for years (Distributor agronomist D).

However there was lack of consensus among advisors responding to the questionnaire about this aspect of farmers' knowledge with only an average of 48% of all advisors (excluding conservation advisors) agreeing that farmers are technically well informed about soil management. Views explored in interviews suggest that it is the depth of farmers technical understanding of soil management that is limited, as one agri-environment scheme advisor (F) noted:

In a very broad sense farmers practice good husbandry. They are aware of gross errors of management but not aware of more subtle things they can do. For soil protection, they're aware of most obvious things but most don't fully understand the topic. There's awareness that the problem exists on one level but not yet sufficient awareness of issues leading to it.

Whilst awareness has increased and most farmers now know about soil degradation and the on and off site impacts of poor management it is claimed they do not necessarily tie it down to their own practise, nor do they have a full grasp of the actual situation. Some farmers accept they are ignorant in this respect as one (Farmer B) remarked '*I know everything about machinery, a little about crops, but very little about the soil. Even though I work the land, I still don't know enough about soil*'. Here he is talking in a technical and scientific sense but not acknowledging that by working the land he comes to know the soil. Advisors express similar concerns:

I feel soil management is a very important issue that is frequently ignored due to lack of knowledge by farmer, they do not seem to understand the correct balance of nutrients needed within the soil and the cultivation methods related to all the different soil types (ADAS advisor).

This quote demonstrates that some advisers define farmers' ignorance in terms of knowledge of 'balance of nutrients' and 'cultivation method' whereas farmers consider that they possess a less tangible form of knowledge described in terms and phrases such as 'intuitive knowledge', 'being in tune with the soil', or 'understanding the soils'. This feel for soil is linked to their central function on the farm, as one advisor remarked '*They [farmers] don't know necessarily about soils but they have an intuition about soils because that's their livelihood*'. Associated with this is the attachment some farmers have for soil, as one advisor commenting on farmers' response to soil erosion said '*It's like loosing their birthright, farmers hate to see the soil running off.*'

All farmers interviewed appear to have developed a practical 'working knowledge' of their soils through regular cultivation which enables them to gauge its structure and condition. Accordingly soils were often described by farmers in terms of their ease of cultivation, with terms such as 'light and easy' or 'heavy' used. Some drew relationships between soil texture, structure and soil moisture, distinguishing heavier soils as having better natural structure and better water retention but being more difficult to plough.

Despite such knowledge demonstrated by some farmers, poor cultivation decisions and practices are regarded by the majority of advisors as the main reason for soil structural degradation including compaction and surface capping which lead to erosion. This is attributed to lack of thought, as one advisor said '*My view is the level of competence in terms of cultivation is not necessarily that great because farmers don't think about what they are doing'*. More specifically farmers' lack of observation and examination of soil is blamed. Although there is thought to be an enormous amount of understanding of soil amongst farmers the main problem, in the opinion of those advisors involved with helping farmers improve soil structure, is that '*they do not know how to examine their soil to determine how much cultivation is required'*. This lack of inspection is compounded by the pressures to get crops drilled, even when weather conditions are unsuitable, which compact the soil and cultivate deeper than necessary:

It's one almighty rush. There is not enough kicking plods, it's more crash bang wallop and getting in before the next job rather than thinking things through. They only look at top, OK they will scuff in with their boot, the surface where the seed is going, to make sure it's in a good condition, but what happens beyond there… they have very rarely gone out and put a spade in the ground and dug a hole to see what's happening (Farmer L).

However farmers talk about working the land and tend to describe and gauge soil in terms of its response under cultivation drawing on their knowledge of local conditions such as weather, as one farmer states:

The weather is so important, this land, my father taught me, he said 'the one thing that works this land is weather and you will never force it', and he was so right. Because it is heavy land, you have to cultivate dry or drill dry, you can't do both wet and expect to get a good crop (Farmer Y).

This demonstrates that while advisers and technical experts have come to rely on soil inspection with spade, and like to 'think things through' farmers look to soil response under different cultivation and weather conditions and are driven by other imperatives such as cropping timetables.

These results suggest that although there is considerable knowledge of the soil, farmers do not have sufficient understanding to make the link between certain practices and their consequences 'there's awareness that the problem exists at one level but not yet sufficient awareness of issues leading to it', suggesting that their understanding of how things happen, and the processes involved, are poorly developed. Farmers do have variable levels of spatial and working knowledge and experience, some demonstrate intuitive knowledge and a detailed understanding of how their soils behave under cultivation or changing weather. There is a sense that farmers have some knowledge but not enough, they are 'in tune but equally ….there is considerable ignorance' or 'there is an enormous amount of understanding about the soil but where farmers fall down is they won't examine it'. Examination using a spade is a process that advisers have come to rely on and implement. Although with this method they are able to interpret the soil conditions they observe at a certain place and time, they do not have the opportunity to work the soil, experience a range of weather conditions, nor do they experience the multitude of other imperatives that farmers experience in running a farm. The research in England helps to characterise the nature of knowledge held by farmers, and has revealed some area where it differs from the advisors perspective on soil.

5. SWITZERLAND

5.1 Context

The aim of the research project in Switzerland was to study farmer perception of soil, compare it with scientific perception and derive suggestions for implementation of soil conserving practices in agriculture. The study was conducted during the years 1994 and 2001 (Fry 2001).

5.2 Methodology

Several actor groups are involved in soil protection. In order to compare the groups who differ strongest the perception of small farmers in the midlands of Switzerland and the perception of scientists working as researchers in the field of soil science are shown here. As a basis for comparison the local practice of knowledge production of farmers and scientists was chosen (Turnbull 1993; Agrawal 1995). The perception of farmers and scientists was examined by means of qualitative methods (participatory observation and episodic interviews) and compared using document analysis (publications, photographs). For details on the methodology see Fry (2001).

5.2 Results

While farmers tend to perceive soil and plant properties incidentally mainly during field work, when using farming equipment under varying conditions, scientists focus on certain soil properties by intentionally choosing a site, taking a sample and transporting it into the laboratory where analytical measurements and specific experiments are carried out under controlled conditions. Following examples illustrate these findings:

During the interview farmer George M. described his soil as follows:
"There, the soil has a yellow tinge when freshly ploughed. Over there, it has some marshy areas and back there it gets loamy. There, I have to change gear, it is much tougher. And there in front of the hollow, the whole spot is marvellous. When I've ploughed it's already nearly harrowed. The soil crumbles, it is so fine. And one can see that as well; it has run up beautifully." George M., farmer

For each area of soil George M. mentioned a characteristic sign: the first has a yellow tinge, the second has marshy patches and is loamy, and the third is crumbly and fine.

The farmer describes colour and structure of the soil properties by describing his experiences while working the soil: he has to change gear because a certain part of the field is much harder to plough. He also relates the soil characteristics to plant growth.

On the other hand soil scientist Hans W. describes another procedure:
P. Fry: When you go to a farm, how do you assess soil quality?
Hans W.: I divide the problem into different aspects to deal with. So, first of all I would go into the natural soil properties, independent of the farming: Am I situated in a moor land? Am I on sandy soil? What is the "mother material"? What vegetation was there before the soil was cultivated? Is it a young soil, an old soil?"
Hans W. Agronomist, advisor

As an agronomist he first looks at natural soil properties which are even independent of farming. He knows how the soils developed in that specific area during the last centuries and what vegetation grew then. From that he goes on to the actual situation today. So his view has a totally different scale with respect to time and space. He takes reference to knowledge derived from scientific literature.

In the following example the perception of soil compaction is compared:

"The farmer does not think of soils suffering damage over the long term. Moreover he pays attention whether the cultivation he wants to sow suffers damage. But at least indirect there are connections. My father made following experience: When he was able to mould a ball out of this soil like a snowball, and then ploughed and sowed never the less, then the rapeseed (?) went red fourteen days after running up. When the leaves discolour it is a sign that the rapeseed somehow does not get soil like it should. That means that the roots cannot get down. These are such xx running up damages." Kurt I., farmer,

„At those parts where the harvesting machine turned the water stands in the winter. When the water goes away nothing grows. The wheat which was sown in autumn has died or grew yellow because the soil just does not work: Compacted, no oxygen, bacteria don't work, the decomposition does not go. Paul K., farmer, 47 years

The farmer Paul K. explains in what situations he observed soil quality. What he sees is also embedded in time and space. But he refers to his daily experiences with working the soil, seeing how the plants come up well or badly and with harvesting. He does see a connection between soil texture, soil moisture and compaction. He also tests the soil by making a mould – or his father did. He sees that heavy machines compact the soil and that the wheat did not grow properly in those parts. It is relevant to him when the plants don't grow properly. But it is not the changing soil quality over the long term which he is interested in. He also uses scientific knowledge about decomposition processes in the soil which need oxygen.

The perception of soil compaction by Soil scientists is dominated by their methods of inquiry. They use methods like the spadetest which can be conducted in the field. With a special spade a 50-60 cm deep profile is excavated. By looking at the structure, texture, colour, moisture and even smell of the soil very detailed connections between the cultivation, used machinery and soil properties can be derived. But mostly soil scientists work with sophisticated laboratory methods. They chose a site, take samples and transport them to the laboratory where they can measure unnumbered properties under controlled conditions. This allows comparing different soils around the world. The methods soil scientists use lead to quantitative data. In a report on soil quality observation for the public we read the following:

"The average of the medians over all ten sites results for the topsoil of the pasture examination sites a xx of 53.1 Vol % and 47.6 Vol % for the artificial pasture respectively." Soil Protection agency Canton Berne 1997, p.155

This difference between pasture and sown grassland is evaluated as follows:

"The difference of the total pore volume (only topsoil) of absolute 5.5 Volume % seems to be small at first. When one takes into account however that a soil with 30 Volume % total pore volume is considered to be extremely compacted and therefore not fertile, the difference becomes even more crucial. When one simply relates a pore volume of >53 Volume % (Pasture average) with 100 % fertility and <30 Volume %

(extreme compaction) with nil, the comparison for the average sawn grassland comes to a reduction of fertility of 76.2%. The difference amounts to nearly 24 %."
Soil Protection agency Canton Berne 1997, p.155

We moved to a different world when comparing how farmers and scientists talk and write about soils. They both describe soil texture, colour, moisture etc. but they use different methods and describe soil properties in a different context. Farmers use the context of working the land whereas scientists choose the context of a special question and sample the land using a specific method to do so.

6 FRANCE

6.1 Context

Runoff and erosion cause great damages in a French Region underlain by loamy soils. Slope is low. Crusting is the main driving factor of the soil surface evolution which leads to runoff. A team of researchers produces prescriptions to struggle. They propose coordination between farmers to scatter areas contributing to runoff. To make the implementation easier, the common points and the differences of conceptions of runoff and erosion between scientists and farmers were studied.

6.2 Principles and methods

This approach is linked to Weber's comprehensive sociology (1956). In this perspective, conceptions of a reality depend on activity and social position. Given this scientists and farmers can have different conceptions of runoff; these conceptions are revealed by a linguistic analysis of interviews. For this research, I have worked with 8 interviews of farmers of the same catchment, done in 2002, and 4 interviews of scientists of the team working in the same catchment. Only some common technical conceptions of each group have been studied, without internal differences due to social positions.

6.3 Results

The research on the struggle against runoff and erosion concern two scales. For the first one, the aim is to establish references on the infiltration capacity of soils on micro-plots, linked with surface conditions in relation with crop and soil roughness: *At the beginning, the first work consisted in putting in relation damages facieses and runoff and erosion appearance (Sophie, researcher)*. This was linked with farmers' practices. After, a new approach considers not only what happens in a field, but the global organization of the fields within catchment area:

After, we realized that we had to take into account an area. We have seen that water flooded from one field to another, and we have been interested by the effects of the fields in relation to their neighbourhood (Pierre, researcher).

The way of flows is modelled at a catchment scale. Compensations between fields, according to their infiltration capacity, are taken into account to propose a better (for runoff) organization of fields' location. Within this frame, farmers' conceptions were studied.

6.3.1 Farmers' conceptions about soil degradation

The way farmers conceive production of surface damages processes is quite exactly the same than the researchers'. The descriptions have the following frame:

Technique + rainy event

➔

State of the crop and the soil

+ rainy event

➔

New state of the crop and the soil

➔

Consequences on infiltration and on surface storage of water
and consequences on runoff and erosion

When seedling are done in October,	Technique
And then we have a bare winter	**<u>Scénario 1</u>** + first rainy event
Soil is not too hard	➔state of the soil
If there is a little bit of rain,	+ second rainy event
Immediately, the plant take up the water	➔consequence on water absorption
When rains continuously from October,	
Soil rams down,	**<u>Scénario 2</u>** + first rainy event
After, if it rains, the water flows (Baptiste,	➔ state of the soil
farmer).	+ second rainy event ➔consequence on runoff

For example:

And also, the techniques and the crops which favour or prevent runoff are also the same for the two types of actors. It is the capping of the soil which is responsible, and all the techniques which favour it are bad.

6.3.2 Farmers' conceptions about the flow of water

Scientists distinguish diffuse runoff, and erosion in thalwegs. There are two main results. The first one concerns the scale of observation. Farmers can very precisely describe how the water flows in their fields. But when the water goes out, or for the issue of where it comes from, they are not precise: *It goes toward the next owner, and then to the sea (Thierry, farmer)* or *My field gather all the water within a radius of 15 km (Bernard, farmer).* The second one refers to what farmers see. If they see very well the flow of water in the thalwegs, they don't perceive diffuse runoff: *To the eye, you nearly cannot see it. And at the end, one day, water arrives here (Norbert, farmer).* And they talk about the speed of the water more than about its quantity.

Farmers have the idea of the effect of patchwork of fields on runoff: the main cause of actual damages is for them the extension of fields' area, which have destroyed the ancient global patchwork. But the idea that it can have compensations of runoff between two neighbor fields, due to their state of surface is not an idea which appears in their discourses.

6.3.3 Farmers' conceptions about the way they consider neighbor fields

For scientists, two neighboring fields are considered in terms of the state of their soil and crop, in relation with infiltration capacity. When farmers talk about two neighboring fields, it is about their field, and the other one is not considered as another field, but directly as the neighboring farmer. *The upstream neighbor, it is a pasture (René, farmer)* or *At that time, it was small squares, there were a furrow that we stopped with the neighbor (Norbert, farmer).*

The consequences of these conceptions are that farmers don't think to compare the states of the fields. What they say when arrive the question of organization is:

I can't say that my neighbor send me some water; in any case, the water have to go down (Baptiste, farmer) or *If you say to your neighbor, hey, you, you will do a water reservoir here, and me, I will not do anything. It is you who are upstream to do something. He will say: why me and why not you? (Camille).*

What appears is that there is no “intermediate object”, as the state of the fields, that farmers can share to negotiate a coordination of their actions.

7. DISCUSSION

7.1 COMPARISON OF THE THREE CASE STUDIES

The three studies, in England, Switzerland and France, show the same two key results: farmers have considerable knowledge of soil functioning on their fields, and their knowledge or perspective is not the same as the scientists.

In terms of the nature of knowledge. The results from Switzerland strongly reflect those from England where farmers have a considerable working knowledge related to soil response under cultivation, they have a wide knowledge but not necessarily any depth of understanding, as one advisor in England noted farmers ‘are aware of gross errors of management but not aware of more subtle things they can do’. Farmers tend to know about ‘working the land’ but according to one advisor they have ’rarely gone out and put a spade in the ground and dug a hole to see what's happening’. The results from England also revealed that lack of inspection before cultivation is related to an urgency to get the crop established, that is, that factors others than soil govern the farmers actions and level of knowledge, this was also demonstrated in the Swiss study. In England and France results showed that farmers’ awareness and understanding was restricted to what they could see, they were aware of soil problems which were visible such as run off but not of diffuse erosion, as one advisors commented ‘*For soil protection, they’re aware of most obvious things but most don’t fully understand the topic’.*

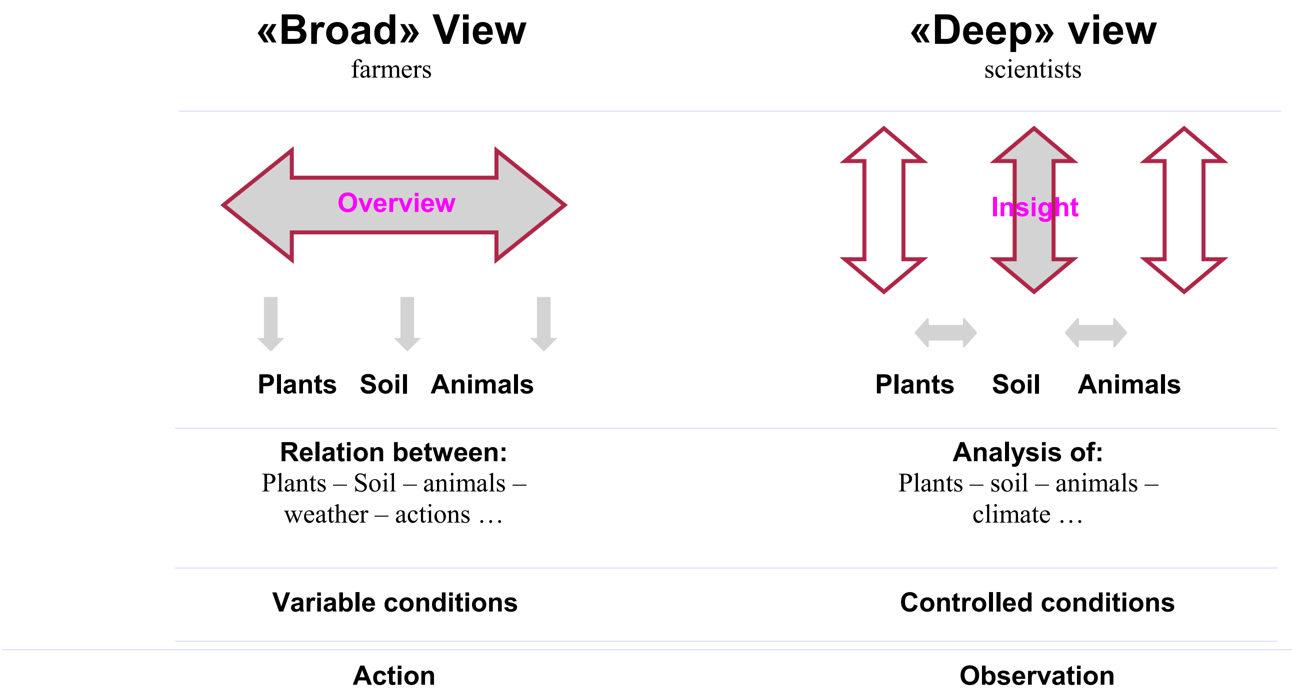
In terms of perspective the three studies demonstrated the distinctions between farmer and scientists viewpoints/knowledge. In England there were clear differences between how farmers and advisors viewed the soil, farmers were criticised for relying on their working knowledge, not regularly examining the soil and not being able to interpret what they see. In contrast advisers rely on soil examinations with a spade which are restricted to specific locations to understand the soil. It is the same in Switzerland where farmers and scientists use different methods and describe soil properties in a different context. Farmers use the context of working the land whereas scientists choose the context of a special question and sample the land using a specific method to do so. In France a difference in the scale of observation was revealed. Farmers although knowledgeable about their own soils and fields, appear not to look at their farm or field in a landscape context or be knowledgeable about the state of their neighbours' fields and soils. In contrast researchers take a catchment perspective, they are acutely aware of catchment processes and see farm boundaries as immaterial. Researchers and farmers also suggest different responses to soil erosion problems in France where farmers talk about the speed of the flood of water, and their solutions to stop it in the thalweg, when scientists talk about the quantity of water, and propose solutions to decrease the water sent by each field.

Farmers' and scientists' perception is directed and shaped by their respective aims, methods and context of work (Fry 2001, see Figure 1). Farmers focus on production of foodstuffs while scientists focus on theories on soil function and processes. These different aims obviously have to be achieved with completely different methods and in different contexts. Farmers work the soil by using the plough or direct drilling under field conditions. A scientist on the other hand quantifies certain soil properties by taking samples in the field and examining them under controlled conditions in the laboratory. The key problem facing scientists is how to standardize and generalize their achievements, in order that they are replicable in different local contexts (Clark and Murdoch 1997: 41). On the other hand farmers face the main problem how to cope economically in a high industrialized agriculture and how to cope with diseases, unpredictable weather conditions etc (as demonstrated in England) While scientists can extrapolate measurements to larger region – assuming that the measurements are comparable – farmers have an overview over the properties of their land and an impression of the state of the soil and their crops. Scientists and farmers however rarely reflect on, or acknowledge, these differences in aims, methods and context. When moving in another working context, which is necessary when we are interested in implementing soil protection in agriculture, inevitably there are problems.

Figure 1: Differing views of farmers, scientists (soil protection) and scientists of basic research (Fry 2001).

	Farmers	**Scientists (soil protection)**	**Scientists (basic research)**
Aims:	Production (Plants, animals)	Protection (Maintain soil quality)	Theories (Functions, processes)
Methods:	Action (seeding, harvesting) Perception during work	Policy work /Monitoring Incentives /Quantification	Experiment Quantification
Contexts:	Field Farmland	Field / Standardized Polluted / investigated sites	Controlled Examined plots /universal

Figure 2: An explanation of implementation problems: Broad view of farmers versus deep view of scientist (Fry 2001).



These results can be explained theoretically in different ways. In Switzerland the differences in aims, methods and context of scientists and farmers are explained as follows. We can characterise the view of farmers as ”broad”, the view of scientists as ”deep” (Fry 2001, Figure 2). While farmers are mainly concerned with maintaining soil under variable conditions - the level of action -, scientists, tend to focus on examining soil under controlled conditions – the level of observation. The scientists gain deep insight (large arrow) on their topic by neglecting the broader connections (smaller arrows). On the other hand the farmer needs to know about the interactions between his actions, soil, plant growth and animal health. That is what he does and observes daily. That is why his view is more a broad overview (large arrow) by neglecting the deep insight in the several topics (smaller arrows). The understanding of deep versus broad view explains very nicely the conflicts which can occur when scientists and farmers meet. Neither has the appropriate insight to communicate meaningfully with the other.

In England the notion of knowledges forms can be used to explain the nature of farmers' knowledge, their considerable working knowledge of their own soils, learnt from experience can be conceptualised as tacit knowledge which itself is comprised of 'know how'[6] (Lundvall and Johnson 1994) or 'practical knowledge' (Thrift 1985). Their absence of understanding of 'the more subtle' things or not 'thinking about what they are doing' suggests that they lack what Lundvall and Johnson (1994) call 'know- why'[5], know why is an element of scientific knowledge, it is the knowledge of principles, rules and ideas of science and technology which scientists and technical advisors use. This explanation helps in some ways to explain the different perspectives of farmers and scientist/advisors.

In France, a social perspective is used to explain the result (Putnam, 1984; Weber 1956). Farmers and scientist have different activities and social positions and as such do not use the same vision of reality; they do not have the same representation of the world (Putnam, 1984). They do not speak about soil in the same way, with the same words, the same categories, the same features (Darré, 1999, Darré and al, 2004). It can be argued that scientists and farmers do not have the same representation of soil functioning, due to their differences of activity. The explanation is here that inside a social group, farmers inside a catchment, or researchers in a team, people talk together of elements of reality (here, soil, crop and runoff and erosion) to resolve their own problems. In the same time, they create norms to act, and they transform the way they describe reality. Conversely, the way a social group describes and conceives reality over the words determine in a part his actions (there is also tacit knowledge that I don't take into account). For example, farmers talk about the speed of the flood of water, and their solutions lead to stop it in the thalweg, when scientists talk about the quantity of water, and propose solutions to decrease the water sent by each field.

This perspective also explains the conflicts between farmers and scientists when they meet. They talk of the same reality, which is under their feet, but, even if they use the same words, they do not refer to the same things. For example, for farmers the term "neighboring field" refers to the man who cultivates it and for scientists to a comparison of the state of the soil . Then farmers imagine how to negotiate an action with his neighbor, and scientists calculate the possible balance of infiltrability between the two fields. If they are not aware about these differences of conceptions, scientists will propose innovations, or solutions to solve a problem which cannot be incorporated in the system of representation of farmers. This is a way to explain a part of the failure of programs of development (Olivier de Sardan, 1998)

The three theoretical explanations proposed should not to be viewed in isolation as together they help to explain how farmers' and scientists' knowledge and perspectives differ in the three examples given. The 'broad' view of the farmer is linked to his social group norm, his culture of being a farmer and talking a broad relational view. His tacit knowledge or know-how of working the land is also linked to this 'broad view' as he intuitively relates his knowledge about cultivations to the weather and to agronomy, etc. The language of his tacit knowledge with words such as 'heavy' or 'light' is linked to his conception of reality and his proposed use of the soil. Conversely the 'deep' view of the scientist focuses on a narrow aspect of the farm it is underpinned by precise language, method and measurement which is part of the world of being a scientist. Scientists like to 'know why' and explain things by processes, they also like to reduce things to specific questions and prioritise particular factors.

7. 2. IMPLICATIONS FOR COMMUNICATING BETWEEN SCIENTISTS AND FARMERS

These results have helped us to differentiate between the views and with this also the aims, methods and context of work, of farmers and scientists. In particular they have revealed the different forms of knowledge used, the depth of knowledge and different conceptions of reality. The challenge is to use these new insights to develop more effective knowledge exchange between the two groups.

To enhance communication between farmers and scientists the exchange of knowledge in both directions is recommended. It is recommended that farmers and scientists develop measures against soil degradation in a mutual way, by looking for solutions in the context of farmers' work and preferably with farming equipment. The exchange of knowledge on the basis of personal knowledge and meaning will lead to a better diffusion and application of knowledge. This can be achieved through participation, consultation, facilitation. The notion of trading zones has been proposed which can give a new impulse towards finding new forms of knowledge exchange in spite of differing aims, methods, contexts and even languages (Galison 1997). Others have stressed the value of individuals developing 'interactional expertise' in bringing together knowledges produced in farming and scientific contexts (Carolan 2006). Dialogue between farmers, advisors and scientists intended to improve understanding and to share knowledge have already proved effective in some initiatives in the USA (Romig et al., 1995; Walter et al., 1997; Liebeg and Doran, 1999) while enhancing personal interaction in participatory activities and networks have been shown to bring opportunities for both parties to learn from each other (Hassanein and Kloppenburg 1995; Coughenour and Chamala, 2000; Nerbonne and Lentz, 2003; Eshuis and Stuiver, 2005). The effectiveness of social learning has also been demonstrated in collaborative programs based on small, local groups for example in Australia. (Millar and Curtis 1999). Here the interchange of local and scientific knowledge in groups was shown to have a synergistic effect, whereby local knowledge was broadened and strengthened, and scientific knowledge adapted and molded to specific situations.

Another way to increase the efficacy of implementation, especially for innovation design, is when farmers' problems and systems of representation are integrated at the beginning in innovation design. This means that there is learning for both scientists and farmers. Scientists have sometime to transform their object of research; and farmers have sometime to change their representations. From the example of France, three proposals to increase the scattering of fields responsible for runoff on the catchment have been considered. First, to show to farmers, through simulations, the effect of scattering the fields on the flood of water. Second, to create an intermediate object which can be a support of negotiation for farmers' coordination of actions. Third, to study and take into account social for propositions, relations between farmers at catchment scale. Other examples of involving farmers in research programmes have also proved particularly effective (McCown 2001, 2002).

8. CONCLUSION

The results from England have revealed that farmers do possess considerable knowledge about soil however they have a broad and intuitive working knowledge drawn from experience, and lack a detailed understanding or 'know-why' of soil which the advisors possess. The results from Switzerland show contrasting broad and deep knowledge held by farmers and scientists. They reveal a 'different world' when comparing how farmers and scientists talk and write about soils, similarly in France farmers' and researchers' conceptions of soil, their language and interpretation differ. These quite different approaches revealed between farmers and scientists/advisors influence their perception of soil fundamentally and lead to different perspectives and language. This has to be taken into account when developing implementation methods.

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[i] Case studies: Upper Hants Avon Landcare Project and the UK Soil Management Initiative.

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