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Agronomist-farmer knowledge encounters: An analysis of knowledge exchange in the context of best management practices in England

Introduction

Recognition of the negative environmental impacts of intensive agricultural practices has brought calls for a more responsible and sustainable agriculture. In response, farmers are encouraged to undertake a range of "best management practices (BMPs)." According to some, these knowledge-intensive practices require new ways of exchanging knowledge; specifically, learning through mutual interaction and shared understandings rather than dissemination or knowledge transfer (Kloppenburg 1991; Röling and Jiggins, 1994; Morgan and Murdoch 2000). Although there has been an emphasis on understanding how these knowledge processes operate in group learning contexts, research into the way that knowledge is exchanged in one-to-one advisor-farmer relationships, which are extensively developed in England, has been limited. As such, this paper reports the findings of research into knowledge exchange at encounters between one group of agricultural advisors (agronomists) and farmers. In particular it examines the potential role of the agronomist in facilitating farmers' implementation of BMPs.

New practices – new ways of exchanging knowledge

The extent of environmental degradation, notably soil erosion and water pollution, resulting from intensive agricultural practices is well documented in Europe and the USA (Joint Nature Conservation Council 2002; Trautmann et al. 1998) and has brought calls for a more responsible and sustainable agriculture. A raft of policies and initiatives has aimed to address these issues on both sides of the Atlantic [Dobbs 1993; Commission of European Communities 2002a; Department for Environment, Food and Rural Affairs (DEFRA) 2002] with agricultural policy increasingly incorporating environmental practices [Dobbs and Pretty 2001; Natural Resources

Conservation Service (NRCS) 2002]. The notion of best management practices (BMPs)[1] which comprise a suite of voluntary good husbandry techniques aimed at reducing soil and water quality impacts, has become a central tenet of these policies in England (DEFRA 2000, 2003, 2006). Understanding the processes that enable knowledge about such practices to be exchanged between land managers and those that support and influence them is essential if polices aiming for sustainable agriculture are to be effective.

Sustainable practices are considered complex, knowledge intensive and non-prescriptive (Röling and Jiggins 1994). The knowledge and management richness of BMPs such as integrated crop management (Park et al. 1997), conservation tillage (Coughenour 2003), nutrient management (Smith et al. 2000) and soil management (Auerswald and Kutilek 1998) has been emphasized. The need for more observation, monitoring and judgment when implementing them, which calls as much upon local or tacit knowledge as scientific knowledge, is also stressed (Kloppenburg 1991; Pretty 1995; Morris and Winter 1999; Tebrugge and Bohrnsen 2001). In short, these practices are thought to be qualitatively different from more conventional one-off technologies (Hassenein and Kloppenburg 1995; Coughenour and Chamala 2000). As such they require new ways of knowing which go beyond the notion of knowledge transfer to, and adoption by, farmers (Earle et al. 1979; Napier et al. 1984; Nowak and Korsching 1998). Principally, sustainable agriculture is considered to involve a shift in the paradigm of farming which can only be achieved by sharing knowledge through social interaction (Vanclay 1992; Röling and Jiggins 1994; Pretty 1995). Accordingly, collective learning, using mechanisms such as participatory approaches, farmer-farmer interaction, and farmer-researcher and social

[1] BMPs (also referred to as Good Management Practices or Good Agricultural Practices) are based on the principle of improving resource management; although aimed primarily to benefit the environment, they also offer cost savings. Examples relevant to his study include nutrient management by budgeting, reducing and targeting artificial and organic fertilizers; timing cultivation and operations to avoid soil damage and reduce erosion risk; reducing cultivations to prevent structural damage to soil and save energy and labor costs; promoting and managing soil organic matter to improve soil structure. In the USA BMPs have been introduced as a federal initiative, they include soil conservation and other agronomic practices and aim to provide water quality benefits.

networks, has been used successfully to achieve a reorientation towards more sustainable practices in some contexts (Hassenein and Kloppenburg 1995; Cerf et al. 2000; Ison and Russell 2000; Röling and Wagemaker 2000; Frost and Lenz 2001; Kilpatrick 2002; Coughenour 2003; Nerbonne and Lentz 2003; Eshuis and Stuiver 2005). Facilitation of such group activities, where individual facilitators empower, enable, re-skill and reorientate farmers and help them to think through what they want and how to achieve it, has been critical to their success. It has brought about longer term effects than other mechanisms which simply make information and advice available, particularly in the context of less prescriptive sustainable practices (Bager and Proost 1997; Kilpatrick 2002; Garforth et al. 2003).

Although group activities are undeniably important for enabling farmers to learn, farmers employ a range of methods when seeking information and principal among these in England is the use of agricultural advisors. Indeed the individual farm visit by an agricultural advisor remains one of the most powerful and effective methods of communication in the farming community and is highly valued by the farmer (Jones et al. 1987; Eldon 1988; Fearne 1990; Angell et al. 1997). Today the advisor's role is more essential than ever in providing the necessary specialist support to farmers as they struggle to meet the demands of changing technologies of production, legislation, environmental processes, and policy issues. Some argue this is particularly the case given farmers' increasing reluctance to share knowledge with their peers as each tries to retain a competitive advantage (Angell et al. 1997; Garforth et al. 2003). Since the privatization of the extension service in England in 1997, independent and commercial agronomists in particular have become important and influential actors on the farm. The increase in their numbers is testament to their importance (Winter 1995; Garforth et al. 2003).[2] Independent agronomists (also called crop consultants) are paid per acre by the farmer while commercial agronomists, who work for agrochemical companies, provide advice as part of a package of agrochemical sales. In England agronomists can provide on-farm advice on all aspects of the agronomic system. Some confine their advice to agrochemical recommendations

[2] For example, in 2002, 96% of farmers used an advisor in the UK (JT Research Agribus 2003) reported on the website *Farmers Weekly Interactive* (May 2006); and in 2006, four out of five of "barometer" farmers who feature in the UK's popular farming journal *Farmers Weekly* employ an agronomist (Farmers Weekly, November 4th, 2005).

while others take a whole farm approach and increasingly developing their environmental skills (Marshall 2002; Ingram and Morris, 2008). Whilst it is accepted that agronomists are significant players in the agricultural knowledge system, little is known about the nature of the relationships they develop with farmers in terms of knowledge exchange. It is pertinent therefore to ask whether they can act as facilitators in helping farmers to re-skill and learn about new, more complex BMPs.

Conceptualizing the advisor's role

Studies of agricultural innovation or extension have conceptualized advisors variously as disseminators or change agents (Rogers 1995), individuals who assist policy makers in the implementation of policies and in changing farmer behavior (Long and van de Ploeg 1989; van den Ban and Hawkins 1996); agents of the state (Vanclay and Lawrence 1994); field level bureaucrats delivering agri-environment policy (Cooper 1999; Juntti and Potter 2002); purveyors of expert knowledge (Burgess et al. 2000); technical experts (Tsouvalis et al. 2000) and representatives of agribusiness with a commercial agenda (Hawkins 1991; Ward 1995; Lyon 1996). These all cast the advisor in the role of the expert who disseminates technical information and policy messages as part of the tradition of top-down agricultural extension. Agronomists have been characterized as influential technical experts. They have been associated with sustaining the "treadmill" of farming, and are regarded as having a dominant and powerful role on the farm (Ward 1995). Farmers conversely are seen as being highly dependent upon their advice (Ward and Munton 1992). Agronomists' commercial interests have also been shown to lead them to exploit and manipulate, rather than support, farmers; this inevitably compromises the relationship, leading to distrust and suspicion (Hawkins 1991; Lyon 1996). Indeed the farmers' reliance on the agronomists tends to breed doubt; as Nerbonne and Lentz (2003, p. 69) point out "lack of independence causes [farmers] to distrust those who control their success."

These inadequacies however have been recognized within the extension community (Rogers 1995; Bergsma 1996, 2000; Lowe et al. 1997; Shaxson 1997; Burgess et al. 2000; Tsouvalis et al. 2000). It has been long been acknowledged that agricultural advisors need to establish an information exchange encounter and to develop a rapport with farmers by showing that they are

reliable, competent, credible, impartial, trustworthy and can empathize with clients' needs and problems, whether in a commercial or extension situation (Engel 1997; Juntti and Potter 2002; Waldenstrom 2002). It has also been argued that, of all advisors who visit the farm, agronomists are best placed to establish such relationships with farmers due to their regular on-farm meetings, local knowledge, and often long-term relationships with farmers (Angell et al. 1997; Ingram and Morris 2008). The independent agronomist in particular is seen as an impartial and trustworthy source of advice (Eldon 1988; Gasson and Hill 1996). Rather than persuade farmers to undertake new initiatives or comply with regulations, as some advisors do, agronomists support practical farming decisions and, as such, their knowledge, interests, values and expectations are more likely to coincide with those of farmers. The importance of such mutual understanding has been identified as central to advisors' engagement with farmers (Ison and Russell 2000; Sheath and Webby 2000), as has the advisors' ability to view the situation from the farmer's perspective in the diagnosis of problems (Rogers 1995; van der Ban and Hawkins 1996). Possessing an intimate knowledge of farming practices, as agronomists do, is also regarded as a crucial factor in the advisors' ability to place themselves in the "shoes of the farmer" (Dalton, 1980). Indeed Giles (1983, p. 324) highlights the reciprocal nature of the relationship asserting that on-farm advisors may personally gain enriched experience and knowledge "by listening and talking to those in the industry who accept the risks and take decisions." Such personal interaction in a context of shared experiences is also thought to be the only way to communicate knowledge about more sustainable practices (Hassenein and Kloppenburg 1995; Morgan and Murdoch 2000).

Advisors and power

Traditionally extension is associated with power and intervention; it is a persuasive device to get farmers to do something someone wants them to (Long, 1992; Gray et al., 1997). Within the policy implementation process advisors are understood to occupy a powerful and influential position as they seek to persuade and manipulate farmers to their agenda (Jones et al., 1987; Long and van der Ploeg, 1989; van der Ban and Hawkins, 1996). The description of a 'change agent' as 'an individual who influences clients' innovation-decisions in a direction deemed desirable by a change agency' reveals where the power lies in the traditional farmer-advisor relationship (Rogers, 1995 p. 335). The notion of the commercial agronomist as being part of the

momentum to control and expand agrochemical use and maintain the "chemical paradigm" (Ward 1995) or "treadmill" of innovation (Röling and Jiggins 1994) places them in a more powerful position than the passive and dependent farmer, reluctant to contradict expert advice (Ward 1995). However, increasingly advice is becoming demand driven (Garforth et al. 2003) and, given that BMPs are voluntary, the power of the farmer as the ultimate decision maker must be a consideration. Clearly the balance of power between agronomists and farmers – who are backed by different resources and interests – is an element that needs to be examined in this research. A number of commentators have recognized that an understanding of power dynamics, where different interests or influences are expressed, is crucial to knowledge exchange within social encounters (Giddens 1986; Law 1986; Arce and Long 1992; Dissanayake 1992; Scoones and Thompson 1994; Long and Villarreal 1994; Gray et al. 1997).

Given this discussion it is clear that agronomists' exchange of knowledge with farmers is set against a background of different sorts of relationships or encounters which are influenced by power. The heterogeneity of the agronomy community is a further consideration in this respect, since they have different backgrounds, and possess a range of qualifications, skills and values (Marshall 2002; Ingram and Morris 2008). This research examines the nature of different agronomist-farmer knowledge exchange encounters and considers whether agronomists have a potential role in facilitating the reorientation of farmers that many believe is essential to managing complex systems and achieving new practices and outlooks in farming (Röling and Jiggins 1994; Curry 1997; Bager and Proost 1997; Engel 1997; Morgan and Murdoch 2000).

Methods

This research was part of wider study looking at the role of different types of farm advisors in relation to the effectiveness of three initiatives promoting BMPs in England. This paper reports on one part of the study which looked at the interaction between farmers and their agronomists. Agronomists are not extension agents – they are employed by farmers or commercial organisations, not projects. They are therefore not directly concerned with the promotion of the initiatives in this study. They are, however, increasingly aware of the need for farmers to meet

environmental regulation requirements and to protect natural resources through the use of more benign practices. They are also a major influence in decision making on the farm.

The UK Soil Management Initiative (SMI) is a nationwide independent organization which aims to address the problems of soil compaction, structural degradation and erosion by promoting cultivation practices including reduced tillage. The Landcare Partnership operating in the Upper Hampshire Avon catchment in the south-west of England aims to control diffuse farm pollution by promoting practices which restrict sediment run-off and loss of nutrients. Practices include appropriate field cultivation techniques and the use of nutrient budgeting and nutrient management plans. The Sundial Fertiliser Recommendation System (FRS) is a tool to help farmers predict inorganic nitrogen (N) fertilizer requirements while enabling nitrate leaching to be minimized. In the first two cases, demonstration and workshops run by the project team and publications were used as the main mechanism to promote BMPs. Advisors working for partner organizations in the Landcare Partnership, employed by government agencies, NGOs or delivering agri-environment schemes, also supported the project aims. In the Sundial FRS program, agronomists and farmers were involved in trialling the FRS which had been developed by research scientists.

Selection and sampling of farmers for interview was based on attendance at demonstration days and involvement with the project. For SMI all farmers (15 in total) who had attended two recent demonstration days were approached and of these six agreed to be interviewed. These comprised farmers typically operating large arable units (>500 acres) in the East and East Midlands regions. In addition, two farmers from the SMI board of directors were interviewed. Twelve farmers had been involved in the development and testing of the Sundial FRS; of these, three felt they had fully engaged to a sufficient level to justify an interview. For the Landcare Partnership, all farmers (eight in total) who had attended a recent demonstration event were contacted and four agreed to be interviewed. Their farms are typically mixed crop and livestock operations, with cereal, dairy cattle and sheep and some pig rearing. An additional farmer who had provided demonstration sites for the project was also interviewed. All farmers interviewed used an agronomist. Interview details are provided in Table 1.

For agronomist interviews relating to the SMI initiative, independent agronomists specializing in combinable crops, cultivation, or soil management (50 in total) were identified from directories of the Association of Independent Crop consultants (AICC) (120 members) and

the British Institute of Agricultural Consultants (BIAC) (280 members). Commercial agronomists with these specialisms were identified from lists of seed merchants, farm management companies and agrochemical distributors. Fifteen in total agreed to be interviewed for this project. For interviews relating to the Landcare project all independent and commercial agronomists, seed merchants, farm management companies and consultants (20 in total) operating within the catchment were identified and contacted using the AICC and BIAC directories, and the local telephone directory, 11 agreed to be interviewed. This approach ensured that both independent and commercial agronomists were interviewed for these projects. For the FRS project all five independent agronomists associated with trialling the FRS with the farmers were interviewed. Although the results reported here concentrate on the interviews with agronomists, they also draw on interviews with those employed by the partner organizations in Landcare which were conducted as part of a wider study. It was not the intention to identify any particular farmer or agronomist types in the interview selection due to the inherent difficulty in categorizing these diverse communities. It is accepted that the farmers and agronomist may have agreed to be interviewed because they had a particular position they wished to articulate. However the results show that the interviews captured a range of views and approaches and, as such, it is considered that the sample did not favor any particular group or opinion.

Although linking interviews would have been methodologically preferable, it was decided not to attempt to interview farmers and their agronomists since many of the agronomists had a strong sense of client confidentiality and in many cases did not want to reveal their clients' names or details. Also it was felt that some individuals would not have been as open if they knew that their farmer or their agronomist was also being interviewed. Unfortunately, an occurrence of foot and mouth disease among livestock at the time also prevented observation of farmer-agronomist interaction in the field. The approach using face to face interviews however provided different accounts and interpretations of their interaction and helped to both triangulate data and paint a picture of the variety of knowledge exchange encounters.

The interviews with farmers and advisors were "semi-structured" in that they consisted of conversations informed by common themes relevant to the issues addressed by the BMP initiatives. Questions sought to understand how farmers and agronomists used and valued each other as a source of knowledge. The defining elements of the relationship between the farmer and agronomist were also teased out during the interviews, for example, interviewers asked

about the length of their relationship; the agronomist's responsibilities with respect to the farm; how decisions were arrived at with regard to particular practices; and how farmers responded to advice and whether there had been agreement, conflict, misunderstanding, or negotiation about the agronomist's advice. Topics referred to both agronomic issues and more specifically to BMPs. The interviews were recorded, transcribed and then coded manually. Analysis consisted of the researcher identifying recurring themes in relation to the issues of power and influence, as well as the individuals' values in relation to sustainable agriculture. On the basis of the responses and analyses, it was possible to distinguish expert-based and facilitative knowledge exchange encounters. Although loosely characterized in the literature, these categories were not predefined but emerged from the analysis of the interview data.

Knowledge exchange encounters (KEE) at the agronomist-farmer interface

This research revealed that knowledge exchange at the interface between agronomists and farmers is characterized by the interaction of knowledge and power. Different types/categories of encounters can be identified, expert and facilitative, distinguished by the quality of the social interaction and the nature of knowledge exchanged across the interface. They are described in the following section and the implications for BMP outcomes are discussed.

Expert knowledge exchange encounters

Expert knowledge encounters occur within a broad spectrum in relation to the interaction of knowledge; at one end agronomists behave as proactive experts and farmers defer to their advice (A); while at the other end agronomists, although still acting as experts, they merely react to farmers' demands (C). Between these two extremes, encounters between agronomists and farmers are more interactive, characterized by divergence of knowledge (B). This spectrum is depicted diagrammatically (Figure 1) as lying across two axes which represent the extent of power exerted by the farmers and by the agronomists.

[Figure 1 about here]

Expert Knowledge Exchange Encounter (KEE: A)

In this encounter agronomists behave as experts: they are proactive and in a dominant and powerful position. These agronomists, through their extensive and regular contact with farmers, "have a very strong influential power with the farmer," as one independent agronomist (R) put it, with regard to farming decisions. These agronomists often take a paternalistic view: they want to protect farmers and feel responsible for the outcomes of farmers' decisions. For example, the expert agronomists describe their concern when farmers are attracted to new practices for the wrong reasons, as one said referring to some farmers' enthusiasm for a change of cultivation practice and equipment "What I'm most keen on is that they don't go into it blindly attracted by the big shiny pieces of metal." Others demonstrate a disrespectful or even contemptuous attitude; one agronomist, commenting on his role on the farm, said, "I do nearly all the rotations, I don't know why, I shouldn't need to, I mean what the hell do farmers do? What do they actually do?" Agronomists tell farmers what to do and can often be dogmatic; "I never withdraw a recommendation" or "No, you listen to me" are agronomist statements that epitomize the agronomist's approach in KEE: A.

In these encounters (KEE: A) farmers are reactive. They come to rely on agronomists as experts and develop a high dependence on their advice; they delegate decisions to them and have "complete faith" in the agronomist's expertise. Part of this delegation is because farmers consider agronomists to be specialists in an area in which they are not so confident. As one farmer (MF) remarked "He's [agronomist] the expert. I leave it to him." For such farmers, agronomy is time consuming and an ever-changing industry. They regard agronomists as providing a service, something that can be parceled-off to someone else, thus:

> The sector of farmers we deal with, they are deferring technical decision making to someone else. They are increasingly stretched doing more acres with less staff. They are much more involved on the farm than they were 20 years ago. They tend to delegate for chemical decisions, variety decisions and fertilizer to people like me. (Distributor agronomist RW)

The agronomist appears to play a significant role on the farm, as a farmer (P) said, "Yes, your fate is in their hands. I have to say they play the most important role. You need to be absolutely

happy the guy you've got is the right guy for you." Being a confidant and "having the ear of the farmer" as they walk around the farm makes these agronomists influential in terms of management practices; often they are the first person the farmer will talk to if thinking about changing practices. These agronomists are confident in their abilities and are not risk-averse; they can be authoritarian and expect the farmer to respond. In these encounters, knowledge follows a largely one-way path across the interface between agronomists and farmers. Agronomists define BMPs: they are not open to discussion. As these proactive agronomists are so influential, their values and orientation with regard to resource protection are crucial, as the following contrasting statements demonstrate: the first encouraging soil degradation, the second critical of practices that lead to it.

> For maize growers, there's a very short time and it's very much a pressure job, we're all screaming at them "you must have maize in by 10 May" whether the soils are capable or not. (Distributor agronomist RB)

> I'm not happy for it [erosion]. It looks terrible, it's ridiculous and I will give them some advice. I have banged the gong for many years. I've kept on about seedbeds and soil wash. Oh yes I would haul them over the coals and say "for Christ sake look it's ridiculous. You're loosing half your field, apart from polluting the river. I don't usually loose customers by being rude to them, although I'm quite rude. (Independent agronomist J)

Clearly different values can lead to different outcomes with regard to use of BMPs on the farm within expert encounter A.

Divergent Knowledge Exchange Encounter (KEE: B)

Although some farmers do accept the agronomists' advice unquestioningly as described for KEE A, other agronomist-farmer encounters are characterized by greater interaction. Farmers respond to advice, or utilize it, in distinctive ways, and the nature and quality of the social encounter between farmer and agronomist often determines this response. Ultimately the farmer in KEE B makes the decision about use of advice, as one independent agronomist (PT) remarked, "You can give them as many plans and guides as you like but no one's going to force them to do it, it's entirely up to them." From the farmers' perspective, when the advice does not conform to their

own experience or inclinations, they will defer to their own judgment; for example, one farmer (MF) explained "He [agronomist] would come to me with proposals. If I thought they were right we would do them, if not I'd modify them to what I wanted to do." Agronomists are increasingly making more targeted fertilizer recommendations intended to reduce the risk of leaching; this is a key area for implementation of BMPs. However farmers often partially override results to simplify them, as one advisor explained:

> If you have a group of 6 fields away from the main holding perhaps 5-6 miles down the road, which is very common these days, it may be that soil indices for NPK would require perhaps 2-3 different N prescriptions. They'll often take a look at that and say "I can't handle that" and instead go for a blanket approach. (Agri-environment scheme advisor A).

From some agronomists' perspectives, farmers' modifications are regarded as an indication of the farmer's incompetence or his reluctance to improve his approach. Agronomists consider that many farmers reject or modify advice when they do not have full understanding of the more demanding BMPs. Because of this agronomists feel they cannot communicate on the same professional basis. Some view the farmer quite critically in this respect, describing them as "lax" or "not having a clue" about certain practices such as nutrient budgeting, an important BMP. As one independent agronomist (CH) remarked "They [farmers] think 'Oh well, the agronomist says 3 bags to the acre, we'll put 2 on because that's what we've got in the shed and balance up next time.'" Another agronomist described his frustration when, having prepared a specific nutrient budget for a farm, the farmer responded that he had found it too complicated to implement saying, "I just mixed it all together and divided it by the area." The agronomist realized that they were not seeing things in the same light and that the relationship would not work, as he said "That was the end of that, no point of him being miserable or me."

These KEE: B encounters between farmer and agronomist are characterized by divergent perspectives, rejection, and transformation, with both parties lacking understanding of, or respect for, the others' knowledge, ability and experience. They have a different definition of what constitutes best management practice. Farmers reject agronomists' advice as too complex or not fitting-in with their current system. Agronomists fail to acknowledge farmers' experience and

knowledge and the practical constraints they operate under, often dismissing them as uninformed and incompetent.

Expert Knowledge Exchange Encounter (KEE: C)

In KEE: C encounters, agronomists are still called on to provide expert advice but they are, in fact, simply being reactive; they are responding to farmers' requests or "Getting sucked into what farmers ask for without really thinking about it," as one project advisor (M) remarked. Retaining clients by responding to their demands is the priority for agronomists in such encounters. This can be explained by the competitive nature of the agronomy industry and the vulnerability of the agronomists' position, as one NGO advisor (P) explained, "The agronomy industry now is completely cut throat, if an agronomist isn't any good, and isn't up to date, he's out." Farmers are known to shift their loyalty to other "more switched on agronomists" if they lose confidence. They talk of "swapping" or "sacking" them if they fail to provide adequate advice; one farmer even described hiring two agronomists and comparing their advice to check on them. In this type of encounter the farmer is proactive – he is powerful and dictates the terms and the nature of the advice. Agronomists cannot afford to be complacent or risk untested practices in such a competitive industry nor indeed criticize farmer practice, as one independent agronomist (RW) remarked, "Soil erosion would almost have to stand out like a sore thumb for agronomists to say anything." The risk of loosing credibility in the eyes of the farmer governs these agronomists' actions. Some demonstrate a lack of confidence in the BMP options available. Talking about the supposed win-win benefits of some BMPs, one agronomist explained how he perceived the risks involved:

> I'm not convinced. I think there's a danger in that if you say it's all win-win you will lose credibility, because any good advisor or knowledgeable farmer will quickly perceive that there are hidden dangers from the point of view of crop production in this advice. (Independent agronomist A)

Even if the agronomist is committed to the principles of best management practice, these are compromised by the need to keep clients, as one project advisor remarked:

> There are environmental things he [the agronomist] would dearly love to advise everybody on but sometimes it's difficult because the farmers say "I don't want to know about that I just want so and so." (Agri-environment scheme advisor A)

Conversely, where farmers themselves are interested in BMPs, agronomists might respond positively in this type of encounter. For example, the enthusiasm of some farmers for use of reduced tillage – which can prevent erosion – has been the incentive for agronomists to take more interest and to seek training in this practice. Failure to support and respond to these farmers' interests through providing competent advice or interest can lead to farmers sacking their agronomist and choosing to learn using other mechanisms, as one farmer (S) explained, "We had an independent agronomist whom we got rid of because he didn't like it all [reduced tillage] and wouldn't support us. So I went and got trained instead." In this example the farmer defines the BMP and the agronomist follows. Whether farmers' priorities favor BMPs or not, the farmer is powerful and the agronomist is in a vulnerable position and must demonstrate credible and competent advice to maintain his position. In contrast to KEE: A, the motivations of the farmer rather than of the agronomist becomes important with regard to BMP implementation.

These expert-type encounters ranging from (A) through divergent (B) to (C) are not equitable but exist in a climate of power imbalance and distrust. Agronomists and farmers are respectively jostling to control and dictate the terms of the relationship without consultation, respect, understanding, or appreciation of each other's knowledge. In KEE A, as Gray et al. (1997, p. 99) point out, the process becomes "no more than a struggle for influence over behavior, rather than a mutual endeavor for a commonly beneficial outcome." The farmers' reliance on the expert agronomist puts the agronomist in a position of authority, and the farmer in one of dependency, thus resembling Ward's (1995) characterization of these actors' roles. Conversely in more demand-driven KEE: C, where agronomists simply act as mediators or filters of knowledge, farmers can exert power in terms of whom they employ and what advice they implement. Whilst KEE: A encounters suggests a growing reliance on technological advice as over-stretched farmers seek to optimize profits, KEE: C encounters show that some farmers are in fact moving away from supply to demand-driven advice, with professional advisors no longer pushing particular technologies but striving to provide for the farmers' needs in an information-rich agricultural knowledge system and competitive commercial environment, as described by

Garforth et al. (2003). With the latter, as agronomists become more reactive, the farmers themselves become more powerful in the relationship as they can exert control over the advice they seek and use.

The research has shown that the interests of farmers and agronomists do not always coincide, as revealed by the farmer's comment "his [agronomists'] thoughts on life are totally different to mine . . . he's' thinking agronomy, I'm thinking gross margins," illustrating that agronomists' perceptions and assumptions do not necessarily accord closely with the realities faced by farmers. As such in KEE: B, advice is more likely to be questioned, criticized, ignored or changed by farmers. Mutual enhancement and shared learning, which many agree is needed for effective facilitation and advancement of more sustainable BMPs, would appear to be absent from these expert encounters, which take place in a context of a power imbalance, mistrust and lack of dialogue or understanding.

Facilitative Knowledge Exchange Encounters (KEE: D)

In contrast to expert encounters, facilitative KEE: D work as partnerships, where agronomists and farmers combine their experience and knowledge and jointly set objectives based on the farmers' needs. These are equitable encounters where understanding, dialogue and shared knowledge are key elements. Consultation, rather than instruction, is a central component of facilitating farmers' decisions. Terms and phrases such as "guiding," "steering," and "help them try and sort it out" were used by agronomists to describe their strategies in this facilitative role. As one independent agronomist (TB) remarked, "We see ourselves as helping to advise farmers as to the pros and cons in their farming systems." Working together is fundamental to this approach and agronomists and farmers typically describe their working encounter as a partnership.

Agronomists and farmers combine their knowledge and experience to arrive at a joint decision: for example farmers might question the agronomists' fertilizer recommendations and agronomists value their input, often combining the farmer's knowledge with their own, as one agronomist (P) said "I might recommend a rate and the farmer's rates might be 20-30 kg higher, so we come to compromise." These "facilitative" agronomists constantly are referring to farmers' knowledge, often incorporating it into their advice and in some cases using it in

preference to their own because they value its local relevance. As one independent agronomist (PT) remarked "I always ask, does he [the farmer] know more than I do through experience? Do I defer to his logic or do I defer to mine?" Integration of knowledge through compromise, reflection and adjustment is common, as this farmer's comment illustrates:

> We do it between us. He [the agronomist] comes up with a recommendation for nitrogen and it's a different rate than I would put on. So I question him and he says "go by my experience as well." (Farmer MF)

Agronomists and farmers both bring their own experience, ideas and insights to these encounters. Whilst farmers benefit from agronomists' technical inputs, these results reveal that farmer knowledge and experience are an undeniable resource for the agronomist, who integrates this with his own knowledge when providing advice. As one government advisor admitted, "and they [farmers] think they learn from me. I learn far more from them, but let's not tell them that!"

Dialogue through discussion, and listening between agronomists and farmers, help to establish what each of them knows and what they want to achieve. Points of discussion can include overall strategy as well as the specifics such as fertilizer application rates. An independent agronomist (N) explained, "Once the farmer sets the agenda, we then make a strategy. The skill is sitting down with farmers and finding out what he wants." Some agronomists interviewed took the view that farmers should write a statement of objectives for each field and ask themselves, "What are they trying to do? What are they trying to achieve?" All advice can then be based on this. Facilitative agronomists described how, by coming to an understanding about objectives, this strengthens the relationship with the farmer and makes the advice much more effective. Dialogue between agronomists and farmers often provides the basis for a good relationship:

> You'll say to him "look you want to achieve this" he'll say "So how are you going to do that?" and I'll say "so and so" and he'll say "you can't do it like that you have to do it this way." Immediately you have a rapport. (Independent agronomist SD)

Rather than advising in an expert authoritarian fashion, engaging in dialogue immediately informs the agronomist about the farmers' constraints, as revealed in the following example about contour plowing[3].

> It's [dialogue] a very nice way of talking it through because instead of it coming through as a recommendation "plough across the field" you're able to say "what would happen if you ploughed across the slope?" and they say "you can't possibly do that on this field because of x, y and z " and then I'd back off. (Distributor agronomist TB)

Relationships based on dialogue can be long term, often developing into friendship. A level of loyalty builds up, as one government advisor commented, "Farmers are unbelievably loyal to their agronomists, unbelievably loyal."

Facilitative agronomists and BMPs

These results suggest that agronomists can act as facilitators – indeed many agronomists see themselves as providing this service – helping farmers to understand the problems and opportunities within their own farming systems. Facilitative interactions, of course, do not in themselves guarantee a transition to more sustainable practices as they might equally result in more, not less, intensive practices being implemented. There is evidence, however, of agronomists helping to re-skill farmers in BMPs. For example, an independent agronomist (TL) commented, "Soil wash. It's insidious light fine stuff that goes off and you don't really see it, but it's getting them [farmers] to understand it's coming from somewhere and it's having an impact." The terms "educate," "teach," and "lesson" are used by agronomists in KEE: D; not necessarily in a patronizing sense but in terms of raising general awareness about problems as well as teaching certain principles and practices as a way of empowering farmers. Agronomists see that explaining problems to farmers in terms they can understand is an essential basis for effective advice. For example, one explained with regard to the efficient use of N, "For nitrogen

[3] A method of cultivation designed to reduce soil erosion. Plowing is carried out across the slope, rather than up and down it, to reduce the flow of water and thus the potential for erosion.

everything is logical, if you get more rain you get more leaching; thicker slurry, more ammonia goes off. You teach them the basis rules." Farmers benefit from an increased understanding of the processes involved, and where farmers understand the process, they become an equal to the agronomist. In this regard agronomists find that they interact more on a professional level and can adapt their message to the competence of the farmer, and leave more tasks to him. This joint understanding also leads them to a shared definition of BMPs.

A number of these facilitative agronomists see themselves as having an intimate understanding of farmers' practices because they are constantly on farm. They believe they share the same views as farmers in terms of economic and practical limitations. Farmers value this characteristic, as one (B) explained, "My agronomist looks at reduced tillage in same light as me." Sharing the same outlook is seen as vital in achieving more sustainable approaches, as an NGO advisor (B) explained, "If you don't understand the situation from the farmers' perspective you'll never bring them on-side because they see best management practice as being impractical." As such, agronomists' rapport with farmers and empathy with their practical constraints, as described here, can provide the basis for facilitation of use of BMPs.

Unlike expert encounters, facilitative encounters are equitable partnerships where there is a balance of power (Figure 1). They are built on dialogue, mutual respect and shared expectations and this provides the right context for joint learning, which is considered key to achieving sustainable agriculture (Kloppenburg 1991; Pretty 1995). The facilitative encounter provides a platform for consultation illustrated by remarks such as, "The skill is sitting down with farmers and finding out what he wants." Sharing and integrating knowledge through validation of farmers' knowledge also brings opportunities for learning, implicit in the following remark: "I always ask does he [the farmer] know more than I do through experience?" This has been revealed by other researchers (Nerbonne and Lentz 2003). The value of facilitative exchange in drawing together and integrating knowledge also has been highlighted by Engel (1997 p. 53) who observed that "from the outside it is striking that the more closely one approaches the field level, the more dominant role in integrating knowledge appears to be played by interpersonal communication mechanisms." The interviews revealed that talking the same language, seeing things in the "same light," and having a common understanding are necessary for effective knowledge exchange. The key elements of facilitation identified by other commentators and

discussed earlier (Ison and Russell 2000; Sheath and Webby 2000) have been confirmed in this study.

These results reveal that knowledge exchange between agronomists and farmers is not a simple, dispassionate transfer of facts from agronomist to farmer but that agronomist and farmer encounters are characterized both by shared and different interests, and embedded in power and influence. As a result, the practice the farmer implements is a negotiated or facilitated outcome between agronomist and farmer rather than a rigid prescriptive practice "adopted" by the farmer.

Agronomist and farmer types

Identifying those agronomists and farmers most likely to be involved in either expert or facilitative encounters might be useful in terms of targeting interventions, it is however difficult. Agronomists are hard to characterize and categorize because individuals swap between commercial, independent and sometimes public sectors, with a number now engaging with the environmental agenda (Marshall 2002; Ingram and Morris 2008). Independent agronomists are self employed; as such, they are less secure and might be expected to be more reactive in an attempt to retain their clients. However, they may also be impartial; therefore, more likely to be trusted by farmers. Conversely, one might argue that commercial agronomists would be more proactive and less trusted because they have an agenda influenced by selling agrochemicals. Findings from this study suggest that independent and commercial agronomists are equally likely to be involved in any of the types of KEE. Similarly for the farmer, there is no particular category of farmer that was identified as more likely to be involved in a particular KEE. The relationship a farmers builds with the agronomist depends, not so much on his characteristics or those of his farm, but on his level of confidence, how much he wishes to delegate, how much experience and knowledge he brings to the relationship and whether he is prepared to enter into a learning relationship with the agronomist. The type of relationship also hinges on a farmer's respect for the agronomist and the farmer's sense of loyalty. For example, farmers often elect to stay with an agronomist even when his employment status changes. All the farmers interviewed had demonstrated some interest in the initiatives being promoted; they were nevertheless very different in their approach to their agronomists. It is therefore difficult to predict whether certain types of agronomists or farmers are more likely to be involved in certain types of KEE.

Implications for the implementation of BMPs

Whilst it was not possible to measure the outcome of the different KEE in terms of BMP implementation, it is possible to evaluate a potential outcome given the characteristics of the KEE and in light of our understanding that these practices require new ways of knowing. In KEE, confident, assertive agronomists are clearly in a position to influence farmers' behavior; the agronomist's motivations and values consequently play a key role. An influential agronomist with productivist views might persuade the farmer towards less environmentally-sensitive practices, as in: "You must have maize in by 10 May whether the soils are capable or not," whilst one with more awareness of environmental degradation might bring about changes more in line with the goals of sustainable agriculture. Whether this encounter can be effective with respect to BMPS advice is unclear. BMPs are considered complex and non-prescriptive, requiring learning, observation, and monitoring on the farm. Some authoritarian approaches might not be appropriate, for example, criticism such as, ''For Christ sake, look it's ridiculous'' is unlikely to lead to environmentally sustainable activity on the farm. The fact that this agronomist had also "kept on about seedbeds and soil wash" further suggests that this authoritarian approach had not been effective. The agronomist failed to provide the support and guidance for the farmer to learn the principles required to address the erosion problem. The KEE: A relationship appears successful in terms of experts providing one-off packages of technical information to the farmer, but a new approach is needed if agronomists are to help re-skill farmers and support their learning about BMPs. The challenges this presents to more traditional advisors has been highlighted by Pence and Grieshop (2005 p. 216) who recognize that an approach that "consciously encourages relationship and emphasizes a learning environment of equal exchange and interaction demands different skills than an extension based on the transfer of scientific research." It also requires a different approach by the farmer who tends to take the view, "He's the expert. I leave it to him [the agronomist]." This attitude is unlikely to lead the farmer to acquire the new understanding required to implement complex practices; nor does it help nurture a partnership approach to farm decision making.

In KEE: B, agronomists describe farmers as "not having a clue," claiming they reject or modify advice when they do not fully understand it. Such agronomists feel they cannot communicate on the same professional basis and some view the farmer quite critically. When they recommend BMPs such as nutrient budgeting, their recommendations are considered too complex and require new sorts of understanding and knowledge that often farmers simply do not have. Raising levels of farmers' technical competence to bring them in line with agronomists would not only allow them to develop understanding of new practices but would also contribute to a shared outlook and help to make them more equitable partners. However, agronomists also need to understand that some recommendations are unpractical or do not fit farmers' local experience. Advisors have always been urged to view the situation from the client's perspective in the diagnosis of problems (van der Ban and Hawkins 1996) but as Busch (1978) noted, and has been revealed in this study, understanding the farmer's perspective is inherently difficult. The need for agronomists to re-orientate and improve their professional attitudes to enable them to recognize these difficulties has been highlighted by the study's findings. The importance of incorporating farmers' experimental insights and technical adaptations has also been identified elsewhere (van Crowder and Anderson 1997).

In KEE: C the farmers' motivations drive the agenda. This can be positive in terms of greater BMP utilization, for example, some agronomists have sought training so that they can respond to farmers' interests in implementing reduced tillage. However, where farmers have no interest in BMPs, "I don't want to know about that, I just want so and so,'' there is little opportunity for influencing their practice. Only by raising farmers' awareness can this relationship be shifted towards a more facilitative one. Agronomists in this encounter, although often informed about BMPs, are reluctant to recommend these practices because they believe they will risk their credibility. Clearly as Rogers (1995) argues there is a need to provide advisors with technical knowledge as well as social skills to achieve credibility in the eyes of the farmer. Previous research has suggested that advisors lack sufficient knowledge about sustainable agricultural practices (Hassenein and Kloppenburg 1995) and that agronomists have variable environmental knowledge that needs to be standardized (Marshall 2002; Ingram and Morris 2008). Given this it is important that agronomists are well trained, as well as provided with credible management options by the experimental community which they can present to farmers with confidence. It has been argued that in this sort of relationship, advisors work in a "comfort zone" where they

just provide what the farmer wants to know, and fail to spot problems or opportunities on the horizon (Angell et al. 1997); and, in a sense, "close off" non-chemical options (Ward 1995). Ensuring that agronomists have the knowledge and confidence to extend their advice beyond this comfort zone is therefore important.

There is evidence that facilitative KEE: D can provide the right context for effective knowledge exchange, although it is recognized that facilitation could equally impede BMP implementation if the values of farmer and agronomist are both oriented towards more productivist goals. However, it is clear that some agronomists do explain the principles or rules of certain BMPs. Through this activity, and working collaboratively, agronomists can assist and empower farmers to learn and adapt – processes considered to be critical to achieving sustainable agriculture (Röling 1988; Bager and Proost 1997; Curry and Winter 2000). Agronomists in KEE: D tend to have good communication skills, the ability to empathize and listen, impartial, technically capable, and they value farmers' insights. In return farmers in KEE: D view the relationship as a partnership and contribute their own knowledge and experience. Clearly it is not possible to create facilitative relationships artificially since often these have been developed over time and rely on the individual manner and approach of the actors involved. There are some areas, however, which this research has identified, where improvements are possible. The link between credibility and trust is clear, so enhancing the agronomists' credibility through technical training is a step towards a more trusting relationship. The ability to empathize is another key characteristic held by agronomists in these relationships. This client-orientation, as Rogers (1995) calls it, is particularity important in the context of BMPs, as these interviews have shown. Unless advisors can understand the situation from the farmers' perspective they will fail to bring them "on-side." Agronomists with farming experience are more likely to be able to achieve this orientation. Acknowledging farmer knowledge has also been shown to be important and the value of individuals developing "interactional expertise" in bringing together knowledges produced in different contexts has been recognized by some researchers (Carolan 2006). However it is the value of interpersonal skills that has been emphasized most in these findings. This has been noted by other researchers. Some consider that "social expertness" rather than technical expertise is one of the most important qualities possessed by an advisor. Others have pointed out that good communication and relationships do not just happen, but need to be managed (Engel 1990; Gasson and Hill 1996; Lundberg 1997) and that training agronomists to

be “social agronomists” will contribute to more effective delivery (Leeuwis, 2000). Thus training agronomists in communication skills should help them improve engagement with farmers and assist in their transition from expert to facilitator. Above all, the notion of a partnership has been shown to be essential to achieve a successful outcome.

Conclusion

The findings of the study have revealed that knowledge encounters between agronomists and farmers are diverse. Expert encounters are characterized by an imbalance of power; a lack of consultation, trust, shared understanding, respect and dialogue; and knowledge is commonly questioned, ignored, and transformed. Opportunities for changing management practices are limited. However, there is evidence that agronomist-farmer encounters that are underpinned by trust, credibility, empathy, and consultation can provide a more effective context for knowledge exchange—potentially facilitating farmers’ transformation to more sustainable best management practices. The question of how to foster more facilitative encounters is important given that the farming community in England will be subject to more demanding policy and regulation with respect to soil and water management in the future (DEFRA 2007). The agronomy community is dynamic and responsive, and agronomists are already developing their environmental expertise to meet policy demands (Marshall 2002). The challenge now is for them to examine the nature of their relationships with farmers. As Hemidy and Cerf (2000 p. 366) note, “the advisory market can no longer be viewed as a simple balance between the supply of advisory products and the demand for advice” but rather must rely on the dynamic interaction of long-term partnerships between advisors and farmers. This research has shown that achieving such partnerships is possible where agronomists and farmers are knowledgeable and proactive but are also willing to learn from each other and accommodate each others’ knowledges. Future research will need to examine which of the elements that underpin such partnerships, such as joint learning, credibility, trust or loyalty, can be manipulated to initiate a shift towards more facilitative relationships.

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References

Angell, B., J. Francis, A. Chalmers, and C. Flint. 1997. *Agriculture and the rural economy: information and advice needs*. London: DEFRA.

Arce, A.C., and N. Long. 1992. The dynamics of knowledge: interfaces between bureaucrats and peasants. *Battlefields of knowledge: the interlocking theory and practice of social research and development*, eds. N. Long and A. Long, 211-246. London: Routledge.

Archer, J. 2001. Review of current and recent knowledge transfer activities in relation to environmental protection in agriculture. London: Ministry of Agriculture, Fisheries and Food (MAFF) Publications.

Auerswald, K., and M. Kutilek. 1998. A European view to the protection of the soil resource. *Soil Tillage Research* 46: 9-11.

Bager, T., and J. Proost. 1997. Voluntary regulation and farmers' environmental behaviour in Denmark and The Netherlands. *Sociologia Ruralis* 37 (1): 79-90.

Bergsma, E. 1996. The bridge between land use and advisers. *Land Husbandry, the International Journal of Soil and Water Conservation* 1: 81-93.

Bergsma, E. 2000. Incentives of land users in projects of soil and water conservation: the weight of intangibles. *Geojournal* 50: 47-54.

Burgess, J., J. Clark, and C.M. Harrison. 2000. Knowledge in action: actor network analysis of a wetland agri-environment scheme. *Ecological Economics* 35: 119-132.

Busch, L. 1978. On understanding: Two views of communication. *Rural Sociology* 43 (3): 450-473.

Carolan, M.S. 2006. Sustainable agriculture, science and the co-production of 'expert' knowledge: the value of interactional expertise. *Local Environment* 11 (4):421-431.

Cerf, M., D. Gibbon, B. Hubert, R. Ison, J. Jiggins, M. Paine, J. Proost, and N. Röling. 2000, eds. *Knowing and learning for change in agriculture: case studies from industrialised countries*. Paris L'institut National de la Recherche Agronomic (INRA) Editions.

Chambers, R., A. Pacey, and L.A. Thrupp. 1989. *Farmer first: farmer innovation and agricultural research*. London: Intermediate Technology Publications (ITP).

Clark, J., and J. Murdoch. 1997. Local knowledge and the precarious extension of scientific networks: a reflection on three case studies. *Sociologia Ruralis* 37 (1): 38-60.

Cobb, D., P. Dolman, and T. O'Riordan. 1999. Interpretations of sustainable agriculture in the UK. *Progress in Human Geography,* 23 (2): 209-235.

Commission of the European Communities (CEC). 1999. Directions towards sustainable agriculture. Brussels: CEC.

Contant, C.K. 1990. Providing information to farmers for groundwater quality protection. *Journal of Soil and Water Conservation* 45 (2), 314-7

Coughenour, C. M., and S. Chamala. 2000. Conservation tillage and cropping innovation: constructing the new culture of agriculture. Ames, IA: Iowa State University Press.

Coughenour, C.M. 2003. Innovating conservation agriculture: the case of no-till cropping. *Rural Sociology* 68 (2): 278-304.

CEC. 2002a. The Sixth Environment Action Programme of the European community 2002-2012. http://europa.eu.int/comm/environment/newprg/index.htm. Accessed 1 September 2006.

CEC. 2002b. Towards a thematic strategy for soil protection. Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions. COM (2002) 179. Brussels: European Parliament.

Contant, C.K. 1990. Providing information to farmers for groundwater quality protection. *Journal of Soil and Water Conservation* 45 (2): 314-7.

Cooper, N.K. 1999. Street level bureaucrats and agri-environmental schemes: the case of the FRCA project officer implementing ESA schemes in England and Wales. PhD Dissertation, King's College, London.

Curry, N. 1997. Providing new environmental skills for British Farmers. *Journal of Environmental Management* 50: 211-222.

Curry, N., and M. Winter. 2000. The transition to environmental agriculture in Europe: learning processes and knowledge networks. *European Planning Studies*, 8 (1): 107-121.

Dampney, P., W. Winter, and D. Jones. 2001. Communication methods to persuade agricultural land managers to adopt practices that will benefit environmental protection and conservation management (AgriComms). Report to DEFRA Farm Management Improvement Division. London: DEFRA Publications.

Dancey, R.J. 1993. The evolution of agricultural extension in England and Wales. *Journal of Agricultural Economics* 44 (3): 375-393.

Dalton, G.E. 1980. The educational role of farm management extension work by state advisory services. *Journal of Agricultural Economics* 31 (2):149-162.

Department for Environment, Food and Rural Affairs (DEFRA) 2000. Towards sustainable agriculture: a pilot set of indicators. London: Defra Publications.

DEFRA. 2002. The strategy for sustainable farming and food: facing the future. London: DEFRA Publications.

DEFRA. 2003. Codes of good agricultural practice for the protection of water, air and soil: summary. London: DEFRA Publications.

DEFRA 2006. Cross compliance handbook for England. London: DEFRA Publications.

DEFRA. 2007. The protection of waters against pollution from agriculture: consultation on implementation of the Nitrates Directive in England. London: DEFRA Publications.

DEFRA and HGCA. 2002. Arable cropping and the environment: a guide. London: DEFRA Publications.

Dissanayake, W. 1992. Knowledge culture and power: some theoretical issues related to the agricultural knowledge and information systems framework. *Knowledge and Policy; the International Journal of Knowledge Transfer and Utilisation* 5(1): 65-76.

Dobbs, T. L. 1993. Enhancing agricultural sustainability through changes in federal commodity policy: marginal versus radical change. Policy Studies Report No. 2. Greenbelt, MD: Henry A. Wallace Institute for Alternative Agriculture.

Dobbs, T., and J. Pretty. 2001. Future directions for joint agricultural-environmental policies: implications of the United Kingdom experience for Europe and the United States. South Dakota State University Economics Research Report and University of Essex Centre for Environment and Society Occasional Paper. Brookings, SD: University of South Dakota.

Dudal, R. 1981. An evaluation of conservation needs. (ed), *Soil conservation, problems and prospects*, ed., R.P.C. Morgan, 3-12. Chichester, UK: Wiley.

Earle, T.R., C.W. Rose, and A.A. Brownlea. 1979. Socio-economic predictors of intention towards soil conservation and their limitation in environmental management. *Journal of Environmental Management* 9: 225-236.

ECOTEC. 2000. *Economic evaluation of free advice programmes on conservation, pollution abatement and conversion to organic farming.* Report C1752. London, UK: MAFF Publications.

Eldon, J. 1988. Agricultural change, conservation, and the role of advisors. *ECOS* 9 4: 15-20.

Engel, P.G.H. 1990. Knowledge management in agriculture: building upon diversity. *Knowledge in Society* 3(3): 28-35.

Engel, P.G.H. 1997. *The social organisation of innovation: a focus on stakeholder interaction.* Amsterdam: KIT Publishers.

Environment Agency. 2001. Best farming practices: profiting from a good environment. R&D Publication 23. Bristol, UK: Environment Agency.

Eshuis, J., and M. Stuiver. 2005. Learning in context through conflict and alignment: farmers and scientist in search of sustainable agriculture. *Agriculture and Human Values* 22(2): 137-148.

Fearne, A.P. 1990. Communications in agriculture: results of a farmer survey. Journal of Agricultural Economics 41: 371-380

Fell, O.R. 2000. Time to converse: the importance of language, conversation and electronic media in agricultural extension. *Australian Journal of Experimental Agriculture* 40: 503-509.

Fell, L., and D.B. Russell. 2000. The human aspects for understanding and agreement. In *Agricultural extension and rural development: Breaking the traditions,* eds. R.L. Ison, and D.B. Russell, 32-51. Cambridge, UK: Cambridge University Press,.

Frost, J., and R. Lenz. 2003. Rooted in grass: challenging patterns of knowledge exchange as a means of fostering change in southeast Minnesota farm community. *Agriculture and Human Values* 20: 65-78.

Garforth, C., B. Angell, and J. Archer. 2003. Fragmentation or creative diversity? Options in the provision of land management advisory services. *Land Use Policy* 20(4): 323-333.

Gasson, R., and B. Hill. 1996. *Socio-economic determinants of the level and rate of on-farm innovation.* Kent, UK: Wye College.

Giddens, A. 1987. *Social theory and modern sociology*. Cambridge, UK: Cambridge University Press.

Giles, A.K. 1983. Some human aspects of giving and taking farm management advice. *Journal of Agricultural Economics* 34: 317-327.

Gray, I., T. Dunn, and E. Phillips. 1997. Power, interests and extension of sustainable agriculture. *Sociologia Ruralis* 37(1): 97-113.

Hassanein, N. 1999. *Changing the way America farms: knowledge and community in the sustainable agriculture movement*. Lincoln, NE: University of Nebraska Press.

Hassanein, N. and J.R. Kloppenburg, Jr. 1995. Where the grass grows again: knowledge exchange in the sustainable agriculture movement. *Rural Sociology* 60 (4): 721-740.

Hawkins, E. 1991. Changing technologies: negotiating autonomy on Cheshire Farms. PhD Dissertation, South Bank Polytechnic, London.

Hemidy, L., and M. Cerf. 2000. Managing change in advisory services: controlling the dynamics of resource transformation and use. In *Knowing and Learning for Change in Agriculture. Case Studies from Industrialised Countries*, eds. M. Cerf, D. Gibbon, B. Hubert, R. Ison, J. Jiggins, M. Paine, J. Proost, and N. Röling, 351-368. Paris: INRA Editions.

Ingram, J., and C. Morris. 2008. The knowledge challenge within the transition towards sustainable soil management: an analysis of agricultural advisors in England. *Land Use Policy* 86: 214-228.

Ison, R.L. 2000. Experience, tradition and service. Institutional r&d in the rangelands. In *agricultural extension and rural development. Breaking the traditions*, eds. R.L. Ison, and D.B. Russell, 103-132. Cambridge, UK: Cambridge University Press.

Ison, R.L and D.B. Russell, eds. 2000. *Agricultural extension and rural development. Breaking the traditions.* Cambridge, UK: Cambridge University Press.

Joint Nature Conservation Council (JNCC). 2002. Environmental effects of the CAP and possible mitigation measures. Report to DEFRA. London: DEFRA Publications.

Jones, G.E., M.J. Rolls, and R.B. Tranter. 1987. Information management in Agriculture British Library Review and Report 5931. London, UK: British Library.

Juntti, M., and C. Potter. 2002. Interpreting and reinterpreting agri-environmental policy: communication, trust and knowledge in the implementation process. *Sociologia Ruralis* 42(3): 215-232.

Kersten, S. 2000. From debate about degradation to dialogue about vegetation management in Western Australia.. In *Knowing and Learning for Change in Agriculture. Case Studies from Industrialised Countries*, eds. M. Cerf, D. Gibbon, B. Hubert, R. Ison, J. Jiggins, M. Paine, J. Proost, and N. Röling, 191-204. Paris: INRA Editions.

Kersten, S., and R. Ison. 1999. Listening, interpretative cycles and dialogue: process design for collaborative research and development. *Journal of Agricultural Education and Extension* 5(3): 163-177.

Kilpatrick, S. 2002. Facilitating sustainable natural resource management: review of the literature. Prepared for Department of Primary Industries, Water and Environment as part of the evaluation of the Implementation of Best Practice in Sustainable Agriculture project. University of Tasmania.

Kloppenburg, J., Jr. 1991. Social theory and the de/reconstruction of agricultural science: local knowledge for and alternative agriculture. *Rural Sociology* 56(4): 519-548.

Law, J., ed. 1986. *Power, action and belief. A new sociology of knowledge?* Boston, MA: Routledge and Kegan Paul.

Leeuwis, C. 2000. Learning to be sustainable. Does the Dutch agrarian knowledge market fail? *Journal of Agricultural Education and Extension* 7(2): 79-92.

Liebig, M.A., and Doran, J.W. 1999. Evaluation of farmers' perceptions of soil quality indicators. *American Journal of Alternative Agriculture* 14(1): 11-21.

Long, N. 1989. Encounters at the interface. A perspective on social discontinuities in rural development. Wageningen Studies in Sociology 27. Wageningen Agricultural University.

Long, N. 1992. From paradigm lost to paradigm regained. The case of actor-oriented sociology of development. In *Battlefields of knowledge: the interlocking theory and practice of social research and development*, eds. N. Long, and A. Long, 16-43. London, UK: Routledge.

Long, N., and J.D. van der Ploeg. 1989. Demythologizing planned intervention. *Sociologia Ruralis* 29: 227-249.

Long, N., and M. Villarreal. 1994. The interweaving of knowledge and power in development interfaces. In *Beyond farmer first: rural people's knowledge, agricultural research and extension practice*, eds. I. Scoones, and J. Thompson, 41-52. London, UK: ITG.

Lowe, P., J. Clark, S. Seymour, and N. Ward. 1997. *Moralising the environment: countryside changes, farming and pollution.* London, UK: UCL Press.

Lundberg, C.C. 1997. Towards general model of consultancy: foundations. *Journal of Organisational Change Management* 10(3): 193-200.

Lyon, F. 1996. How farmers research and learn: the case of arable farmers of East Anglia, UK. *Agriculture and Human Values* 13(4): 39-47.

Marshall, E.J.P. 2002. Environmental information for agronomists 2002: needs and provision. A report by the Farmed Environment Company for Crop Protection Association UK Ltd. and UKASTA.

May, T. 1997. *Social research issues, methods, and process*. Oxford, UK: Oxford University Press.

Morgan, K., and J. Murdoch. 2000. Organic vs. conventional agriculture: knowledge, power and innovation in the food chain. *Geoforum* 31: 159-173.

Morris, C., and M. Winter. 1999. Integrated farming systems: the third way for European agriculture? *Land Use Policy* 16: 193-205.

Murdoch, J. and J. Clark. 1994. Sustainable knowledge. *Geoforum* 25(2): 115-132.

Natural Resources Conservation Service (NRCS). 2002. *FarmbBill 2002 summary of NRCS conservation programs*. http://www.nrcs.usda.gov/programs/farmbill/2002. Accessed 23 March 2006.

Napier, T.L., C.S. Thraen, A. Gore, and W.R. Goe. 1984. Factors affecting the adoption of conventional and conservation tillage practices in Ohio. *Journal of Soil and Water Conservation*, May-June, 201-209.

Nerbonne, J.F., and R. Lentz. 2003. Rooted in grass: challenging patterns of knowledge exchange as a means of fostering social change in a southeast Minnesota farm community. *Agriculture and Human Values* 20(1): 65-78.

Nowak, P.J., and P.F. Korschin. 1998. The human dimension of soil and water conservation: a historical and methodological perspective. In *Advances in soil and water conservation*, eds. F.J. Pierce, and W.W. Frye, 159-184. Chelsea MI: Ann Arbor Press.

Park, J., D.P. Farmer, A.P Bailey, J.D.H. Keatinge, T. Rehman, and R.B. Tranter. 1997. Integrated arable farming systems and their potential uptake in the UK. *Farm Management* 9(10): 483-494.

Pence, R. A., and J.L. Grieshop. 2001. Mapping the road for voluntary change: partnerships in agricultural extension. *Agriculture and Human Values* 18(2): 209-217

Pretty, J. 1995. Regenerating agriculture: policies and practice for sustainability and self-reliance. London, UK: Earthscan.

Raedeke, A.H., and J.S. Rikoon. 1997. Temporal and spatial dimensions of knowledge: implications for sustainable agriculture. *Agriculture and Human Values* 14(2): 145-158

Rogers, E.M. 1995. *Diffusion of Innovations* 4th edition. New York: Free Press.

Röling, N. 1992. The emergence of knowledge systems thinking: a changing perception of relationships among innovation, knowledge process and configuration. *Knowledge and Policy* 5(1): 42-64.

Röling, N.G., and J.L.S.Jiggins. 1994. Policy paradigm for sustainable farming. *European Journal of Agricultural Education and Extension* 1(1-3): 23-43.

Röling, N.G., and M.A.E. Wagemaker. Eds. 1998. *Facilitating Sustainable Agriculture*. Cambridge, UK: Cambridge University Press.

Romig, D.E., M.J. Garlynd, R.F. Harris, and K. McSweeney. 1995. How farmers assess soil health and soil quality. *Journal of Soil and Water Conservation* 50: 229-236.

Russell, D.B., and R.L. Ison. 2000. The research-development relationship in rural communities: an opportunity for conceptual science. In *Agricultural extensions and rural development. Breaking the traditions*, eds. R.L. Ison, and D.B. Russell, 11-31. Cambridge, UK: Cambridge University Press.

Seppänen, L., and J. Helenius. 2004. Do inspection practices in organic agriculture serve organic values? A case study from Finland. *Agriculture and Human Values* 21 (1): 1-13.

Scoones, I., and J. Thompson. 1994. *Beyond farmer first: rural people's knowledge, agricultural research and extension practice*. London, UK: ITG.

Shaxson, T.F. 1997. Soil Erosion and Land Husbandry. *Land Husbandry* 2(1):1-14.

Sheath, G.W., and R.W. Webby. 2000. The results and success factors of a farm monitoring and study group approach to collective learning. In *Knowing and learning for change in agriculture. Case studies from industrialised countries*, eds. M. Cerf, D. Gibbon, B. Hubert, R. Ison, J. Jiggins, M. Paine, J. Proost, and N. Röling, 111-120. Paris, France: INRA Editions.

Smith, K.A., A.J. Brewer, A. Dauven, and D.W. Wilson. 2000. A survey of the production and use of animal manures in England and Wales. I. Pig manure. *Soil Use and Management* 16(2):124-132.

Tebrugge, F., and A. Bohrnsen. 2001. Farmers and experts opinion on no-tillage in West Europe and Nebraska. In *Conservation agriculture. A world-wide challenge* Volume 1, eds. L. Garcia-Torres, J. Benites, and A. Martinez-Vilela, 61-71. Brussels: ECAF Publications.

Trautmann, N.M., K.S. Porter, and R.J. Wagenet. 1998. *Modern agriculture: its effects on the environment.* Ithaca, NY: Cornell University Cooperative Extension.

Tsouvalis, J., S. Seymour, and C. Watkins. 2000. Exploring knowledge-cultures: precision farming, yield mapping and the expert-farmer interface. *Environment and Planning*, A32: 908-924.

Vanclay, F. 1992. The social context of farmers' adoption of environmentally sound farming practices. In *Agriculture, environment and society*, eds. G. Lawrence, F. Vanclay, and B. Furse, 94-121. Melbourne, Australia: Macmillan.

Vanclay, F., and G. Lawrence. 1994. Farmer rationality and the adoption of environmentally sound practices: a critique of the assumptions of traditional agricultural extension. *European Journal of Agricultural Education and Extension* 1(1): 59-90.

van den Ban, A.W., and H.S. Hawkins. 1996. *Agricultural extension*. 2nd edition. Oxford, UK: Blackwell Science.

van der Ploeg, J.D. 1989. Knowledge systems, metaphor and interface: the case of potatoes in the Peruvian highlands. In *Encounters at the interface: a perspective on social discontinuities in rural development*. Wageningen Studies in Sociology 27, ed. N. Long, 145-163. Wageningen Agricultural University.

van Crowder, L., and J. Andersen. 1997. Linking research, extension and education: why is the problem so persistent and pervasive? *European Journal of Agricultural Education and Extension* 3(4): 241-249.

Waldenstrom, C. 2002. *Constructing the World in Dialogue*. PhD thesis, Stockholm University.

Walter, G., M. Wander, and G. Bollero. 1997. A farmer centered approach to developing information for soil resource management: The Illinois Soil Quality Initiative. *America Journal of Alternative Agriculture* 12(2): 64-72.

Ward, N. 1995. Technological change and the regulation of pollution from agricultural pesticides. *Geoforum* 26(1): 19-33.

Ward, N., and R. Munton. 1992. Conceptualising agriculture –environment relations. Combining political economy and social cultural approaches to pesticide pollution. *Sociologia Ruralis* 32(1): 127- 145.

Winter, M. 1995. Networks of knowledge: a review of environmental advice, training, education and research for the agricultural community in the UK. Report to WWF. Cheltenham: CCRU.

Winter, M. 1997. New policies and new skills: agricultural change and technology transfer. *Sociologia Ruralis* 37(3): 363-381.

Table 1. Numbers of farmers and agronomists interviewed in each case study.

	SMI	Landcare	FRS
Farmers	8	6	3
Commercial agronomists	10	6	0
Independent agronomists	5	5	5

Note: See *Abbreviations*.

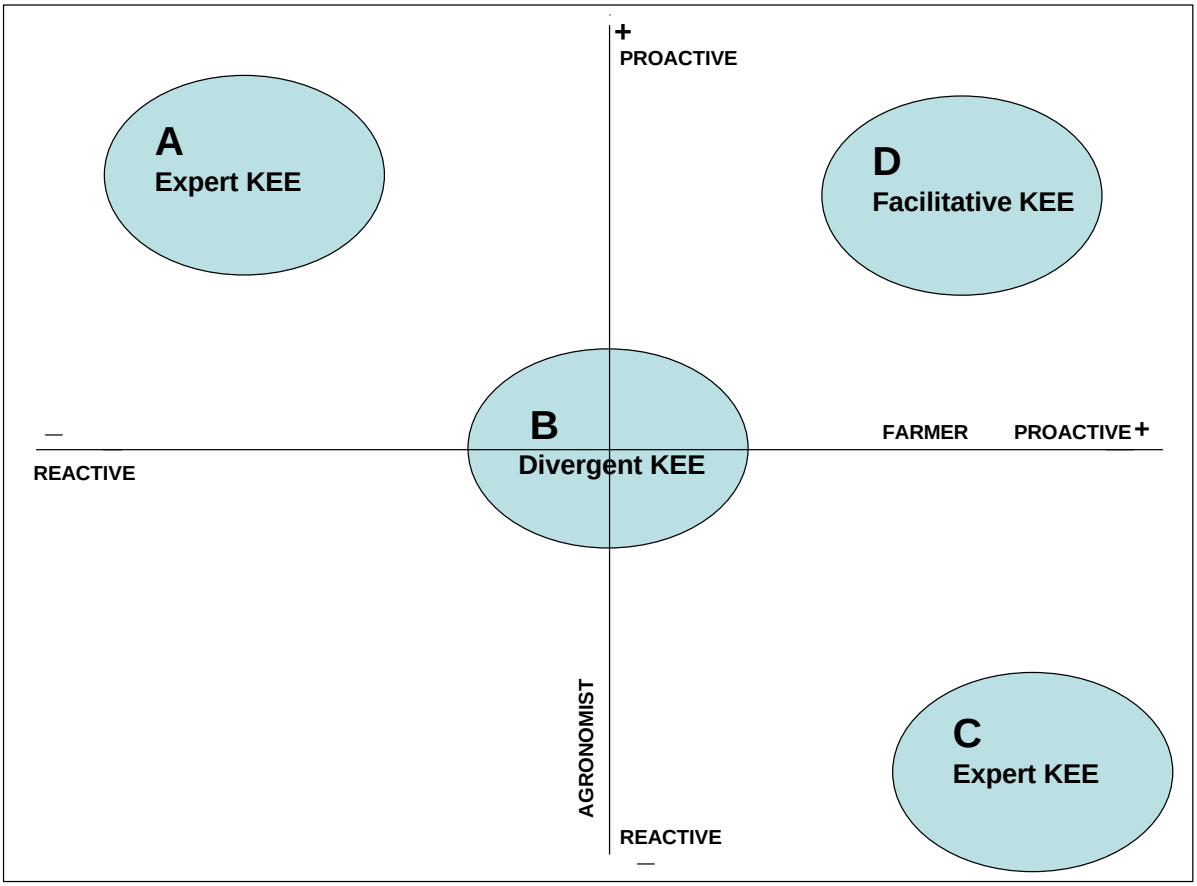

Figure 1. Agronomist-farmer knowledge exchange encounters (KEE).