Management practices to enhance soil carbon: using stakeholder consultation to evaluate credibility, salience and legitimacy of information

Julie Ingram and Jane Mills

Countryside & Community Research Institute, University of Gloucestershire, Oxstalls Lane Longlevens, Gloucester, Gloucestershire, GL2 9HW, Tel: +44 (0)1242 714134/4122, www.glos.ac.uk/ccri

Abstract: The carbon content of soil affects physical, biological and chemical properties of soil and is a major factor in its overall health and productivity. Maintaining soil carbon stocks and reducing carbon dioxide emissions also contributes to climate change mitigation. The majority of these functions are closely linked to the stocks and flows of soil organic carbon. There is an impetus therefore for policy makers and scientists in the agricultural context to identify agronomic and soil management practices that can increase carbon stocks and optimise carbon use (flows). This is something the scientific community is addressing.

Such developments raise the issue of communication between scientists and the farming community, particularly given the scientific complexity and uncertainty associated with understanding soil carbon in the agricultural context. This paper seeks to examine the potential gap between research and practice in the context of soil carbon management. Specifically, it presents results from interviews with representatives from the farming community in six European countries in which their views about soil carbon management were explored. This study was undertaken within the SmartSOIL project which is using modelling to identify practices that improve carbon stocks and optimise crop productivity. Analysis is situated within the framework of credibility, salience and legitimacy concepts which are pertinent to understanding boundaries between the scientific and the farming communities.

The results suggest that soil carbon management is perceived and interpreted differently on different sides of the science-practice boundary, particularly with respect to goals, context, language, timescale and scale. This has implications for salience. Perceived scientific uncertainty about the extent to which certain management practices enhance soil carbon is common amongst advisors, revealing issues of credibility. The consultation process has ensured some legitimacy in the project, by enabling feedback to scientists which will help shape the outcomes of the project and make them more suited to potential beneficiaries.

The work was part of the project SmartSOIL (Grant Agreement N° 289694) funded by the European Commission, within the 7th Framework Programme of RTD.

Keywords: soil carbon, mitigation, credibility, salience, legitimacy, boundaries

Introduction

The carbon content of soil affects physical, biological and chemical properties of soil and is a major factor in its overall health and productivity. Maintaining soil carbon stocks and reducing carbon dioxide emissions also contributes to climate change mitigation. The majority of these functions are closely linked to the stocks and flows of soil organic carbon (Smith, 2012). There is an impetus therefore for policy makers and scientists in the agricultural context to identify agronomic and soil management practices that can increase carbon stocks and optimise carbon use (flows). This is something the scientific community is addressing as demonstrated by a growing number of research activities and academic papers which are identifying mitigating practices. However, before such practice can be recommended it is important to understand the perspectives and likely responses of the farming community.

This raises the issue of communication between scientists and the farming community. The difficulties in bridging the divide between scientific or technical solutions and implementation in the field, or translating science into practice, are well known (McCown, 2001; Eshuis and Stuiver, 2005). Often these difficulties are underpinned by a difference in understanding between those developing management technologies and those being asked to use them. This so called science-practice gap has long been recognised and described in different literatures and contexts. In the context of soil management, the difference between scientific and farming communities has been explored and issues such as different knowledges, and differing aims, methods and context of work revealed (Ingram et al., 2010).

Bridging the gap between science and practice with respect to soil carbon management (and communicating about it) presents some particular challenges. Firstly, changes in soil carbon are small compared to the large stocks of carbon present in the soil, meaning that the change in carbon stock can be difficult to measure, presenting problems for monitoring, reporting and verification (Smith, 2012). It is problematic, therefore, to provide evidence of the positive effects of management practices. Secondly, due to the complexity of soil carbon dynamics and the heterogeneity of soil (and associated biophysical settings) and its responses to different managements, there is large uncertainty with regard to the efficacy of different management practices to enhance soil carbon across different soil types, scales and climatic conditions. Scientific debates concerning, for example, the value of reduced tillage for soil carbon (Baker et al., 2007) demonstrate this. Furthermore, there are misunderstandings within the scientific community about the role of soil carbon sequestration in climate change mitigation (Powlson et al., 2011). Thirdly, scientists tend to favour modelling to explain and predict carbon processes, and this methodology is not easily understood by outsiders. The science, therefore, is complex, in some cases lacks consensus and tends to be inaccessible to the lay person.

In addition to this, soil carbon management is framed within the climate change debate, with the farming community often contesting the evidence and scenarios of predicted impacts. GHG emissions from the agricultural sector are characterised by large uncertainties making it difficult to assess the effectiveness of GHG mitigation measures (Smith et al., 2007). These communication challenges are played out in a wider setting of complex decision making for enhancing terrestrial carbon sequestration, where there are a range of.barriers and opportunities open to land managers (Ingram et al., 2012); for example, the economic trade-offs between existing practices and the practices required to store carbon may constrain the potential to enhance carbon sequestration (Failey and Dilling, 2010).

This paper seeks to examine the potential gap between research and practice in the context of soil carbon management. Specifically, it presents results from preliminary interviews with representatives from the farming community in six European countries conducted within the interdisciplinary SmartSOIL project.

Conceptualisation –salience, credibility, and legitimacy

In the agricultural setting the tensions at the interface between farmers and scientists have been the focus of much scholastic work, with attention given to how the two groups construct issues relating to agriculture (new technologies and sustainable agriculture), conservation and environmental management; and to how they communicate with each other. Farmer - science relations, specifically the nature of the knowledge they hold and the processes involved in the production and exchange of this knowledge, have been well documented (Eshuis and Stuiver, 2005).

The gap between scientific theory and real world practice has been identified as a reason why many science based innovations have not been used to their full potential (McCown 2001). This has been particularly evident in cases of where scientists interact more directly with users. This gap has been conceptualised in a number of ways in the context of natural resource management and agricultural management. Essentially, actors are seen to have different problem perceptions or different ways to frame problems, different perspectives on the world around them and belong to communities with different epistemologies. Conceptualisations emphasise different actors' perspectives informed by their knowledge, values, interests, context, lifeworlds, and experiences. They also describe distinctive groups of actors which develop as a result of the evolution of social, economic and cultural dynamics, for example knowledge cultures (Tsouvalis et al., 2000), knowledge systems (Turnbull, 1993) and Communities of Practice (COP) (Wenger, 1998).

The notion of boundaries has been used within these literatures to conceptualise cultural, epistemological, science-policy gaps (Jasanoff 1987; Wenger, 1998). In the science and technology (S&T) literature, the notion of boundaries has been used to conceptualise the science- action gap between communities of experts and decision makers (Cash et al., 2003). They elaborate these specifically with respect to managing boundaries (boundary work) between scientific knowledge and action. According to Cash et al. (2003, p8086) there is a 'prevalence of different norms and expectations in the two communities [experts and decision makers] regarding such crucial concepts as what constitutes reliable evidence, convincing argument, procedural fairness, and appropriate characterization of uncertainty'. Although pertaining to science policy interface this body of work on boundaries is relevant to the interface between scientists and the farming community.

Based on evaluations of scientific advice and environmental assessments Cash et al., (2003) assert that demands for useful information fall into three broad categories: salience, credibility, and legitimacy. They argue that scientific information is likely to be more effective in influencing the social responses if it is perceived by relevant stakeholders to be not only credible, but also salient and legitimate. Other scholars building on this work have looked at different criteria and thresholds for credibility, salience and legitimacy for effectiveness of joint knowledge production (Hegger et al., 2013) and boundary objects. They argue that these attributes are tightly coupled, need to have equal consideration and be balanced in a dynamic tension.

Credible information is perceived by the users to be accurate, valid, and of high quality. It relates to the nature of the knowledge and methods of its production and perceived validity. Credibility can be interpreted differently in different domains. In scientific arenas it refers to scientific authority and the scientific plausibility of the technical evidence and arguments. In this sense credibility involves the scientific adequacy of the technical evidence and arguments. Status has always been accorded to scientific knowledge, by virtue of its 'rigour', 'systemic' approach and 'rationality' and this has effectively allowed science to stand apart from other knowledge systems. Credibility of information has long been known to influence farmer decision making although more so from the perspective of trust in the source of information. Studies of acceptance of scientific decision support tools by farmers have also revealed the importance of credibility to potential users (Carberry et al., 2002).

Salience refers to how relevant information is to the needs of the decision maker. Actors can be expected to have different knowledge interests, so their criteria for what is relevant knowledge may differ. Relevance of the issue to the practitioners has always been a key concern for those promoting a change in practice. This concern has been apparent in a number of studies of adoption and decision making. Information that is timely and informs decision makers about problems that are on their agendas has high salience. A classic pitfall, according to Cash et al. (2003), is the identification of interesting and tractable questions within a scientific community that have little relevance outside of it, including no bearing on a decision maker's real-world situation. Equally, scientific data developed as part of a political process will not necessarily be relevant to land managers.

Legitimacy reflects the perception that the production of information and technology has been respectful of stakeholders' divergent values and beliefs. Research and practice in knowledge exchange in agriculture has tended to highlight issues such as legitimacy of different knowledge forms, inequality and power dynamics. A general challenge to scientific superiority has favoured approaches based on the principles of consultation, participation, empowerment and ownership of the problem. However, the language of 'adoption' founded in the intervention paradigm prevails in a number of scientific projects (for example, Louwagie et al., 2009). Legitimacy also means that it is perceived to be free from political persuasion or bias.

Given the particular challenges of communicating about soil carbon management outlined earlier, credibility, salience and legitimacy are pertinent. This paper aims therefore to situate analysis of a consultative process in the SmartSOIL project within this framework.

Context and methodology

The research took place within **SmartSOIL** (**S**ustainable farm **M**anagement **a**imed at **R**educing **T**hreats to **SOIL**s under climate change)[306]. The project is using meta-analyses of data from European long-term experiments to model the impact of different farming practices on soil organic carbon in arable and mixed farming systems. This modelling will identify those practices that not only improve carbon stocks but also optimise crop productivity (increase yields cost effectively). It will develop and deliver a decision support toolbox, including a decision support tool (DST) and guidelines for a range of beneficiaries (farmers, advisors, policy makers). Understanding the perspectives of these beneficiaries is an integral part of this project, achieved through stakeholder engagement (the farming and policy community) in six cases study countries: Denmark, Hungary, Italy, Poland ,Scotland and Spain[307]. This is being done through a series of consultative interviews and workshops. For the purposes of the consultations, five sets of management practices were identified as having the potential to increase soil carbon stocks: planting catch (cover) crops, crop rotations, residue management, reduced tillage operations, and fertilizer and manure management. These were selected by drawing on project partner expertise and on an extensive review of research (Flynn *et al.*, 2007).

In a preliminary consultation, 60 interviews were carried out with selected agricultural advisors (from public extension and commercial services), research practitioners and policy makers across the case study regions (approximately 10 interviews per case study). Interviewees were asked about their views on managing soil carbon, in particular about implementing the practices listed above. The results of this consultation will feed back into the scientific identification of appropri-

[306] SmartSOIL is an interdisciplinary project funded by EU Framework 7. It has 12 partners in 9 countries and runs for the period 2011-2015. www.smartsoil.eu

[307] Case study regions: Sjælland, Denmark; Közép-Magyarország, Hungary; Tuscany, Italy; Mazowieck, Poland; Eastern Scotland, Scotland; Andalucía, Spain:

ate soil management practices and the development of the toolbox and DST. The analysis that follows is framed around the notion of credibility, salience and legitimacy.

Results

Credibility

One of the main concerns expressed by interviewees was the perceived scientific uncertainty about the extent to which certain management practices enhance soil carbon. Interviewees from most countries believed that there is no scientific consensus about what are the best practices both for storing carbon and increasing yield under certain conditions. As one advisor noted 'the cause and effect relationship between soil carbon and yield seem to be lacking or very theoretical'. There is a sense that scientists themselves do not yet fully understand soil carbon dynamics and it is only when there is agreement amongst scientists that management recommendations will have real credibility. One UK research practitioner expressed this view:

> *One of the problems is that there is so much uncertainly about C at the simplest level. It would be helpful to have consensus in scientific community first of all. R UK*

Some respondents mentioned the debates about the efficacy of different practices for sequestering carbon and for crop productivity and the fact that systematic assessment of different practices was missing. The result is that advisors are left uncertain about what recommendations to make:

> *Even "experts" [like him] don't know which practice to recommend to farmers when they ask "how can I conserve the quality of soil and mitigate climate change". The practices are too complicated, very difficult to recommend one fertiliser or another because all have different effects and advantages/disadvantages.* J Spain

Interviewees feel that evidence is missing, as one interviewee in Spain said 'Farmers need documentation that a certain change/practice will either increase output or reap other benefits in terms of savings'. An advisor in Italy agreed that 'At the advising level it is crucial to have a proof, and evidence of the effects of a practice'.

Respondents pointed to the lack of evidence that certain practices benefit soil carbon in terms of cost effectiveness and crop yield over a long time scale. In this respect they highlighted the difficulty of demonstrating the positive effects of soil carbon management practices. Dealing with the issue of the heterogeneity of soil at a regional and at a farm scale is also a real concern for some researchers and advisors. Respondents agreed that there is a lack of detailed and up-to-date data sources, particularly in light of the great spatial variability of the subject matter, soil.

Finally, some interviews considered that there is a tendency for politicians' knowledge and action to be based on something political rather that scientific. This led them to question recommendations from scientists.

Salience

Some interviewees felt that scientists (and policy makers) are removed from 'the real world'. In Spain for example one advisor remarked:

> *"Farmers know their practices well. Even if you put lots of effort in to convincing that a certain practice will be good in the long term, I think this will be fairly ineffective. You have to break down barriers between research and day-to-day practice of farmers. Even if the scientific community come to a consensus on best practice, it is likely that the practic-*

es defined will be so far removed from current practice that they won't implement it. If the messages we want to communicate do not convey economically viable ideas, then they will be worthless". A Spain

This suggests that although a scientific consensus, and the credibility this brings, is important, that relevance to practice and to the farm business is a key factor. Farmer decision making (and hence the decisions of the advisors who support them) is largely driven by economic motivations. Currently, there is no demonstrable commercial incentive for farmers to consider managing carbon. Consequently, soil carbon management is seen as low priority or not even a consideration by farmers. Although there is increasing awareness of other soil management issues due to regulation (e.g. cross compliance), soil carbon management is only indirectly related to this and does not fit within the frame of regulatory incentives in which farmers operate. Many farmers are only concerned with complying with regulations, as one advisor in Poland remarked: *'Farmers do not expect advisors to provide them with technological information. They want support on how to fulfill the EU requirements'*. In Hungary, land managers were described as paying little attention to soil carbon management, it is seen mostly as a 'by-product' of other soil related activities and regulation. Nor is soil carbon part of the farmers' or advisors' vocabulary or every-day language, although they might talk about soil organic matter which is recognised as relevant to soil health and productivity.

Furthermore, it is clear that most production-related decisions are taken in the short-term. This is not compatible with managing soil carbon which needs a long-term approach. Respondents described a range of factors which affect farmers' capacity to act in the long-term, including uncertainty about the weather, policy and market developments in addition to internal farm factors (such as debt, tenure, and family status). As one advisor noted, farmers will be more interested in 'whether you remove the straw this year or not' than in a long term perspective.

Some advisors pointed out that management should not just focus on one aspect of farming, such as soil carbon, as in reality advisors and farmers manage the whole farm. Also with respect to soil management, physical, biological and chemical considerations overlap. Consequently, as one advisor in Italy pointed out, *'information which is too specific [i.e. soil carbon] and communicated as an isolated issue is doomed to failure'.*

Legitimacy

Although not specifically asked about their views on legitimacy of the information available on soil carbon, the responses referred to above infer that the views of the farming community have not been considered in identifying promising practices. This is something that the SmartSOIL project is addressing. This preliminary consultation endeavoured to engage advisors, as the representatives of farmers, and policy makers, research practitioners. Using a range of advisors (commercial, extension, representatives of agricultural chambers and cooperatives) as representatives of farmers clearly has limitations but was considered the best approach given the time and resource constraints of the project. Although the process revealed a number of values, concerns, and perspectives associated with different actors, there was enough commonality to suggest that the process had been sufficiently thorough and fair with respect to the breadth of consultation. Inevitably representation is an issue, however, offering repeated opportunities for engagement throughout the project should help to ensure that the appropriate stakeholders are consulted.

The consultation's main aim was to solicit views about soil carbon management, however, it has also revealed the diverse nature of potential beneficiaries of the project outputs and the contexts they operate in. With respect to opportunities to implement particular practices, regional and country differences are clear (as the examples given above demonstrate); this means that a one-size-fits all approach to dissemination of project outputs is not appropriate. In particular, access to advice is variable. This is related to cost of advice to the individual farmers, as well the quality of advice received; interviewees in some countries, for example, identified poor quality advice/extension. This highlights a need to adapt project outputs to different contexts to ensure that the project outputs are accessible to potential beneficiaries. Thus legitimacy is achieved by being respectful of stakeholders' divergent values and beliefs.

Conclusion

The results would suggest that there are boundaries between the scientific ambitions of the project and the potential end-users in the context of soil carbon management. Perceived scientific uncertainty about the extent to which certain management practices enhance soil carbon is common amongst advisors (and policy makers). Efforts to increase credibility need to be made by providing evidence to potential users about casual relationships. The nature of this evidence needs to be considered; field demonstrations were regarded as the best mechanism for showing the farming community the effects of management practices. However, Cash et al. (2002, p4) points out that 'Credibility is hard to establish in arenas in which considerable uncertainty and scientific disagreement exists, either about facts or causal relationships'. Soil carbon management is framed within climate change which itself is a subject of debate and contention, where credibility of scientific expertise and bias is continually questioned. Arguably, some respondents have emphasised this uncertainty and use this as a device to question credibility. If this is the case, this reveals a greater underlying resistance to scientific outputs in the soil carbon context. With respect to communicating messages and making them more acceptable, interviewees agreed that that complex messages should be avoided, and that simple messages, using the 'right' language, will have the most impact. However, in the case of the DST, for example, simplifying model inputs would arguably compromise the credibility and usefulness of the DST outputs. This illustrates the need to give equal consideration to all three attributes.

Soil carbon management is perceived and interpreted differently on different sides of the science-practice boundary, particularly with respect to goals, context, language, timescale and spatial scale. This has implications for salience. The scientists operating within the frame or discourse of climate change mitigation put carbon at the centre of their research. They use results from long term experiments and modelling to provide evidence for soil carbon changes under different practices. Farmers and advisors are concerned with profitable food production and have a whole farm view, they do not single out one aspect of management, such as soil carbon. As previous researchers have shown, scientists dealing with soil are concerned with one small element of the farmers' world—soil (Liebig and Doran, 1999; Ingram et al. 2010), indeed an even smaller element if the subject is reduced to soil carbon. Nor are the time frames used by science relevant to farmers and advisors who are concerned with short term decisions and tasks, not long term effects on soil. Farmers also operate at a small scale under unpredictable and heterogeneous situations which are unsuited to 'uniform' scientific outputs. Aware of these salience issues, the project is endeavouring to provide figures on cost effectiveness and yield impact of the practices identified as promising. The project also will try to integrate soil carbon management recommendations into wider farm scale wide advice; and consider the impact of introducing carbon credits.

Consultation increases the process of identifying promising practices in the project. However, efforts to increase legitimacy by extending the consultation across six case studies may have negative effects on wider salience by re-framing the issue in a way that is irrelevant to some stakeholders. Issues of poor quality advice in Poland, for example, and tenure issues in Spain raised by respondents are not relevant to those in Denmark or Scotland. Designing project outputs must take this into account. The project also needs to be aware that efforts to increase legitimacy can decrease credibility as the science can be seen as being 'tainted' if too many stakeholders bias the process. This can occur in soil management debates about soil tillage if, for example, commercial interests are involved.

Consulting end users (and providing access to the process for multiple perspectives which enhances legitimacy) has revealed the importance of credible and salient information to the farming community. It has also shown that there is a dynamic interplay between the three attributes. Results for this analysis are being fed back into the scientific modelling work packages of the project. In addition, further interviews and workshops will be conducted to build on this preliminary consultation and provide further insights to shape the development of the SmartSOIL toolbox, DST and guidelines.

References

Baker, J.M., Ochsner, T.E., Venterea, R.T. and Griffis, T.J. (2007). Tillage and soil carbon sequestration –What do we relaly know? Agriculture, Ecosystem and Environment 118: 1-5

Carberry, P.S., Hochman, Z. McCown, R.L,. Dalgliesh, N.P, Foale M.A., Poulton, P.L., Hargreaves,,J.N.G., Hargreaves D.M.G, Cawthray S., Hillcoat N., Robertson, M.J. (2002). The FARMSCAPE approach to decision support: farmers', advisers', researchers' monitoring, simulation, communication and performance evaluation. Agricultural Systems 74: 141–177

Cash, D.W., Clark, W.C., Alcock, F., Dickson, N., Eckley, N., Guston, D., Jager, J., Mitchell, R. (2003). Knowledge systems for sustainable development. Proceedings of the National Academy of Sciences of the United States of America 100 (14): 8086–8091.

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

Failey, E. and Dilling, L. (2010). Carbon stewardship: land management decisions and the potential for carbon sequestration in Colorado, USA. Environmental Research Letters. 5: 1-7.

Flynn, H, Smith, P, Bindi, M, Trombi, G, Oudendag, D and Rousseva, S. (2007). Deliverable D3: Practices description and analysis report. PICCMAT – Policy Incentives for Climate Change Mitigation Agricultural Techniques. Available at: www.climatechangeintelligence.baastel.be/piccmat/spaw/uploads/files/WP1_d3_Report.pdf.

Hegger, D. Lamers, M. Van Zeijl-Rozema, A. and Dieperin, C. (2012). Conceptualising joint knowledge production in regional climate change adaptation projects: success conditions and levers for action. Environmental Science & Policy 18: 52-65

Ingram, J., Fry, P. Mathieu, A. (2010).. Revealing different understandings of soil held by scientists and farmers in the context of soil protection and management. Land Use Policy. 27: 51–60.

Ingram, J., Mills, J., Frelih-Larsen, A. and Davis, M. (2012). Uptake of soil management practices and experiences with decisions support tools: Analysis of the consultation with the farming community SmartSOIL Deliverable 5.1. Available at www.smartsoil.eu.

Jasanoff, S. S. 1987. Social Studies of Science 17: 195–230

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

Louwagie, G., Gay, S.H. and Burrell, A. (2009). Final report on the project Sustainable Agriculture and Soil Conservation (SoCo).

McCown, R.L. (2001). Learning to bridge the gap between science-based decision support and the practice of farming: evolution in paradigms of model-based research and intervention from design to dialogue. Australian Journal of Agricultural Research 52 (5): 549–572.

Powlson, D.S., Whitmore, A. P., Goulding, K.W.T. (2011). Soil carbon : a critical reexamination to identify the true and the false. European Journal of Soil Science 62, 42-55.

Smith P., Martino D., Cai Z., Gwary, D., Janzen, H.H., Kumar, P., McCarl, B., Ogle, S., O'Mara, F., Rice, C. et al. (2007). Policy and technological constraints to implementation of greenhouse gas mitigation options in agriculture. Agriculture, Ecosystems and Environment 118: 6–28.

Smith, P. (2012). Soils and Climate Change. Current Opinion in Environmental Sustainability 4: 539–544

Tsouvalis, J., Seymour, S., Watkins, C. (2000). Exploring knowledge-cultures: precision farming, yield mapping and the expert-farmer interface. Environment and Planning A 32: 908–924.

Turnbull, D. (1993). Local knowledge and comparative scientific traditions. Knowledge and Policy 6: 29–54.

Wenger, E. (1998). Communities of Practice, Learning, Meaning, and Identity. New York: Cambridge University Press.