SmartSOIL

Sustainable farm Management Aimed at Reducing Threats to SOILs under climate change

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Uptake of soil management practices and experiences with decisions support tools: Analysis of the consultation with the farming community

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Executive summary

This report provides an analysis of the consultation with the farming community carried out within Task 5.1. This task entailed consultation with the policy and advisor community in the six case study regions and countries (Sjælland - Denmark; Közép-Magyarország - Hungary; Tuscany - Italy; Eastern Scotland - Scotland; Mazowieckie- Poland; Andalucia -Spain). The aim was to consult experts both nationally and in the case study regions about two main issues, 1. the current promotion, implementation and barriers to uptake of soil management practices with particular emphasis on soil carbon management, and 2. their experience and requirements of DSTs, with particular emphasis on those supporting soil carbon management.

Face to face and telephone interviews with carried out with policy makers and advisors in each case study country. Respondents were selected based on their expertise and experience in relation to the soil and crop management. The interview schedules were developed using expert knowledge, a literature review and partner consultation.

1. Current promotion, implementation and barriers to uptake of soil management practices with particular emphasis on soil carbon management

The type of soil/crop management practices promoted nationally and in the case study area with particular emphasis on the soil carbon management practices listed

There is no evidence of specific Government policies for promoting soil carbon management practices in any of the case study countries. Soil carbon management is very rarely a subject of advice on its own, but it is an integrated part of other programmes such as cross-compliance, fertilizer management programmes and agri-environmental schemes. Currently the cross-compliance measures represent the most active legislative tool dealing with soil management practices. However often the focus is on legal requirements of GAEC and to a lesser extent on practical and technological information. Measures are promoted through a combination of regulation and voluntary incentives. A range of promotional activities using different materials and mechanisms were described. Knowledge dissemination in relation to soil protection problems lags behind other environmental issues in Hungary and Poland often due to limited staff and financial resources.

The extent to which farmers and advisors are aware of, advise on and implement soil management practices with particular emphasis on soil carbon management

The extent to which farmers and advisors are aware of soil carbon management practices varies considerably between the case study countries. In some countries, such as Denmark and Scotland there is a growing awareness of the issue, particularly amongst organic farms and large agri-businesses while in others, for example Poland, awareness is generally low. The extent to which soil carbon management practices are implemented seems to be predicated on the level of farm economic security, as many farmers (and some advisors) are unconvinced of the economic benefits. For farmers and their advisors economic priorities prevail and profit maximisation is a driver.

Barriers to the promotion and uptake of soil management practices

Debates about the efficacy of different practices for sequestering carbon and for enhancing productivity were described and a lack of consensus about best practice. The perception of scientific uncertainty limits the credibility of any recommendations. Related to this is the lack of evidence or real examples and the difficulty of demonstrating of the positive effects of soil management practices and economic benefits over a long time scale. Improving

scientific clarity on “best practice is though to be critical. *S*oil carbon management practices are often perceived by farmers as uneconomic, impractical or expensive to implement because they require investment in new technology. Lack of technical knowledge or familiarity with practices compounds this. Also commercial imperatives often override good practice.

Incentives (and actions required) to encourage uptake of soil management
It was agreed that farmers are predominantly motivated by economic actions and decisions and have a relatively short-term outlook. Incentives therefore need to be financial, provided either as subsidies or by demonstrating the financial gains of implementation. Regulations or sanctions were less popular suggestions, while most partners suggested improving advisory mechanisms, simplifying the message, using the ‘right’ language, targeting advice and making it appropriate at the farm scale and integrating it with other advice programmes.

Information used to design soil protection measures and practices, the format in which this information is available, gaps in knowledge and the level of confidence in the data
Most countries reported good information sources in Hungary and Italy available data is not up-to-date, often not complete, and lacking integration and with different levels of details. Confidence in maps and data was questioned in some countries including Scotland where fields are being constantly remapped.

2. Experience and preferences of DSTs, with particular emphasis on those supporting soil carbon management

Current uptake of DSTs
The degree of experience with and the frequency of uptake of DSTs vary by country as well as within actor groups. However, the uptake of DSTs among farmers and advisers appears to generally be dependent on four factors: (1) relative novelty of DSTs and their emergence only within the last 10-15 years; (2) production orientation and farm size; (3) financial constraints and level of computer literacy; and (4) the impractical, overly complex nature of available DSTs.

Formats, features and examples of available DSTs
Preferences regarding the DST format differ according to age, with older farmers generally preferring written formats and younger farmers feeling comfortable with newer technological formats. Printed materials and the use of maps are prioritized in all represented countries. Online or computer tools offer additional flexibility and allow the possibility to be regularly updated, but run the risk of excluding certain user groups. Additional formats evoke more divided opinions, e.g. recommendation tables, SMS services, smart phone use and one-to-one advice. A toolbox approach is therefore appropriate.

Effective DSTs require a user-friendly and concise interface, be easy-to-use, time efficient and accessible. Personalizing tools for different regions and farm systems is also important. A DST must ultimately balance simplicity for the user with accurate results (complexity) and ease of use.

Barriers and potential for future DST usage
Effective dissemination and implementation of DSTs are challenging. The issues of time and short versus long-term perspectives also threaten DST usage amongst targeted user groups. Scientific ambiguity and a perceived high degree of uncertainty about carbon dynamics, lack of knowledge about climate change and mitigation practices, as well as lacking skills and

information at farm level to provide input in the DST are further barriers. Nonetheless, DSTs are seen as relevant tools for communicating issues and improving knowledge among stakeholders, and for addressing the barriers between research and day-to-day farming practices. The latter requires a reframing of the issues in terms which are more relevant and approachable for all target users. Creating venues for feedback and enhanced education/skills training were also prioritized by respondents in order to optimise potential use.

Integration of tools

The presence of integrated decision support tools varies greatly by case study countries, with the UK having the most examples of such tools. Several other countries cited the lack of integration to date as a result of limited interest, finances and incentives. Ideas for where integration should or could potentially take place included collaboration between national and European projects and harmonizing activities and tools between research and industry.

Expectations for a SmartSOIL tool

Respondents ranked possible content for the SmartSOIL tool, prioritizing the following issues: (1) a priority list of practices which are most cost effective for optimal carbon sequestration; (2) real life case studies of farmers using certain practices; and (3) best practice examples for how to promote a certain practice. Moreover, respondents emphasized the need to frame soil carbon management as an element of sustainable soil management and in terms of production efficiencies, rather than place too much emphasis on carbon management on its own. In particular, the need to integrate topics such as fertilizer, nutrient use, grazing intensity, soil compaction, soil and sward damage, and pesticide use was raised.

Similar to the views regarding DSTs in general, format preferences for a SmartSOIL tool are varied. The format should therefore be determined in relation to specific target groups and the issues at hand. DSTs aimed at farmers should focus on ease of use, while tools directed at advisors can incorporate more complex formats and outputs.

The consultation shows that adopting a toolbox approach rather than developing a single overarching SmartSOIL tool is likely to be a more effective approach and that careful consideration must be given to how soil carbon management is framed as part of sustainable soil management. The potential for integration with other tools and the maintenance beyond the life-span of the project needs to be assessed. The possible role of SmartSOIL toolbox as an awareness-raising tool and a tool to facilitate societal debate and decision-making beyond farm level needs to be considered when developing both the toolbox and dissemination activities. SmartSOIL is seen to offer a unique opportunity to coordinate and combine a variety of current initiatives and provide a forum for debate on sustainable soil management.

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1. Introduction

This report provides an analysis of the consultation with the farming community carried out within Task 5.1. The lead partner is UoG with contributors: Ecologic, AU, UCPH, SAC, UPM, UNIFI, SSGW, AKI (the latter 6 being the case study partners). This task entailed consultation with the policy and advisor community in the six case study regions and countries (Sjælland - Denmark; Közép-Magyarország - Hungary; Tuscany - Italy; Eastern Scotland - Scotland; Mazowieckie- Poland; Andalucia -Spain). The aim was to consult experts both nationally and in the case study regions about two main issues, firstly the current promotion, implementation and barriers to uptake of soil management practices with particular emphasis on soil carbon management, and secondly their experience and requirements of DSTs, with particular emphasis on those supporting soil carbon management.

Analysis from this task will be used to feed into Task 5.2: Stakeholder Workshop 1 to consult stakeholders on socio-economic aspects of crop and soil management systems and Task 5.3 Expert interviews with stakeholders/beneficiaries to inform dissemination strategy and activities. Insights revealed in this analysis will also be used to inform WPs 1, 2 and 3 and in the development of a prototype SmartSOIL decision support tool (DST) within WP4.

The report structure is as follows. Section 1.1 explains the methodology used in the consultation. It is followed by the discussion of the results which are presented in two main sections reflecting the two sections in the interview schedules. The analysis of responses concerning soil management practices is presented in Section 2 and the analysis of responses relating to the DST in Section 3.

1.1 Method

Interview method

Face to face and telephone interviewed were conducted and in one case (Spain) a group discussion was held. Interviews were recorded and the digital files retained as a record of the interview.

Respondents

Interviews were carried out with respondents in each case study country (nationally and in the case study region). Numbers varied but on average ten interviews were conducted in each country. Of these half were policy makers (with at least 2 in the case study region) and half were advisors (with at least 2 in each case study region). These were selected to gain both a national and a case study region perspective.

Policy makers interviewed work at the national or regional level and include mid level policy makers who have links with practitioners, for example, those that work in agencies or programmes that implement policy. They were selected for their focus in the area of soil conservation, diffuse pollution or mitigation of climate change. In some cases research practitioners were interviewed who were identified as having knowledge of policy and implementation contexts and particular and experience of DST. Advisors interviewed work at the national or regional level and include arable crop advisors as well as those who work in public good initiatives (eg soil protection, diffuse pollution, climate change mitigation programmes).

Considerable efforts were made to identify and interview the most appropriate person to talk to (ie someone who knows about or has experience of DST in relation to cropping,

diffuse pollution, or soil management) and who was able to answer most of the interview questions. A number of phone calls were made before conducting the interview to establish the right contact. Some partners were more successful at persuading people to be interviewed than others, Scotland and Poland encountered a number of refusals and found it difficult to identify (persuade) people to contribute.

The interview schedule (questions)

Interview schedules were developed for policy makers and advisors respectively (Appendix). The schedules were developed initially from a literature review which identified the most relevant issues to farmer uptake of soil management practice and to DST development and implementation. Partners (CCRI and Ecologic) then refined the schedules using further literature and expertise. Following this a pilot interview stage was undertaken, seven interviews (face to face and telephone) were conducted with respondents in England by CCRI to test the schedules. Following this some minor changes were made before sending the schedules to the partners (see Appendix for schedules). The questions fall into 2 sections relating to the following issues:

i. Soil management practices

- the type of soil/crop management practices promoted area with particular emphasis on the soil carbon management practices listed (catch crops etc)
- how the soil/crop management practices are promoted, including the type of information used in promotion
- the extent to which farmers and advisors are aware of, advise on and implement soil management practices with particular emphasis on soil carbon management
- the main barriers/incentives to the uptake of soil management practices
- the information used to design soil protection measures and practices, the format in which this information is available, gaps in knowledge and the level of confidence in the data

ii. DSTs

- views on DSTs (with particular emphasis on those supporting soil carbon management)
- views on what SmartSOIL can provide (and the formats) that would be most useful

Reporting and Analysis

Each interview was transcribed in English by case study partners in most cases. A summary analysis (2 pages) for each case study of the main points that have emerged from the interviews was prepared by case study partners using a template provided. Analysis of all case study interviews was conducted by CCRI and Ecologic using thematic analysis and N-VIVO for this report.

Guidance

A telephone conference was held prior to this research to go over the schedules with partners to enable them to ask questions, provide some input and feedback and ensure there was common understanding about what was required. As a consequence some further minor changes were made. Written guidance (see Appendix) was also set out for all case

study partners to follow to ensure consistency in all approaches, interview selection, method, analysis etc (Appendix). A template was provided for a summary report.

2. Analysis of responses concerning soil management practices

2.1 Type of soil/crop management practices promoted nationally and in the case study area with particular emphasis on the soil carbon management practices listed (catch crops etc)

There is no evidence of specific Government policies for promoting soil carbon management practices in any of the case study countries. Also soil management practices tend to be integrated with other objectives within environmental programmes. Scotland appears to be the case study country that is most advanced in promoting voluntary uptake of soil carbon management practices through the development of specific climate change programmes that incorporate practices to lock up carbon and sequester carbon through soils. In most of the other countries, soil carbon management is a secondary objective or by-product of other environmental programmes. Poland is the case study country that appears to place the least emphasis on promoting soil carbon management practices, where promotion in focused on soil management practices that meet EU obligations, mainly relating to mainly to cover crops, crop rotations and manure and fertiliser management. All the country reports referred to the national context, except Scotland.

It appears that international and EU obligations play an important role with respect to the current scientific and policy discourse around soil carbon management. Currently advice on soil carbon management focuses primarily on degradation and water quality issues; with respect to climate change mitigation in agriculture there is an emphasis on reducing greenhouse gas emissions and increasing rates of bio-energy use. Generally, soil management practices implemented that relate to soil carbon are the use of crop rotations and fertilizer management in particular as well as residue management (arable stubbles being popular) and minimum tillage.

Denmark
In Denmark soil carbon management is very rarely a subject of advice on its own, but it is an integrated part of an overall crop production strategy aimed at gaining the best economic output. Soil management practices undertaken that are particularly relevant are catch crops, crop rotations, residue management, perennial grasses and fertilizer management, including ash applications for potassium.

Hungary
In Hungary advice on soil management practices focuses primarily on degradation and nitrate pollution issues, there is more emphasis on reducing greenhouse gas emissions and rates of bio-energy in the climate change mitigation context. As a result soil carbon management is not particularly the focus of current practices and policy. From the farmer's viewpoint this is mainly due to a lack of effective (economic) incentives to undertake such practices. Policy makers claim other goals/areas have higher priority, and lack of scientific evidence (or uncertainty) holds back clear policy goals and actions. Soil carbon management practices are mainly a secondary or by-product of other soil related activities/regulation and relate to appropriate crop rotations, organic manure input, reduced-tillage and grass or mulch layers in orchards.

Italy

In Italy there are no specific government initiatives devoted to promoting soil carbon management, however, some of the practices included in cross compliance measures contribute to improving soil carbon in the soil. In particular, measures related to soil protection are relevant, such as minimum tillage, stubble management, crop rotation, and minimum soil cover and terracing maintenance. Appropriate soil management practices are also promoted through the Soil Management section of the Integrated Production Guidelines which mainly relate to soil establishment (e.g. terracing) for soils on slopes and permeable soils; tillage operations and protection against leaching and soil erosion. Another section of the Guidelines provides for measures to increase the soil organic matter through the use of compost, manure or slurry (including incentives). The principles of the Integrated Production Guidelines are integrated into the Rural Development Plan for the Emilia Romagna Region, where financial incentives for specific measures are provided. In terms of promoting voluntary soil carbon practices these relate mainly to organic production and for agri-quality certification (a regional certification exclusively promoted by the Tuscany Region), such as practices relating to the maintenance of soil fertility and organic matter.

Poland

The main soil management practices promoted relate to the requirements for maintaining soils in the good agricultural and environmental condition (GAEC) within cross compliance. It was suggested that measures aimed at increasing soil carbon content are not promoted in Poland due to farmer's lack of interest in such measures, which is mainly focused on fulfilling EU requirements. None of the policy or advisor respondents recognised the significance of farming for climate change mitigation or the need to apply such practices. "F*armers do not expect advisors to provide them with technological information. They want support on how to fulfill the EU requirements*". The types of general soil management practices promoted related mainly to cross compliance measures; specifically, cover crops, crop rotations and manure and fertiliser management were mentioned.

Scotland

There are no specific soil/ crop management practices that are currently promoted by the Scottish Government. However, the Scottish Soil Framework (2009) and Land Use Strategy (2011) identified a range of soil outcomes for sustainable use and management of soil. There are a number of climate change initiatives, diffusion pollution programmes and other generic advice that are available in Scotland. For example, the Scottish Agricultural College run the Farming for a Better Climate initiative funded by the Scottish Government. One of the key action areas is to promote measures to sequester carbon in soils. They provide a range of information on different ideas and techniques for farmers to help them lock carbon into soils. Also the Soil Association Scotland (which promotes organic farming) have run a number of training events under the Climate Change programme and will continue to run events under the Future Proofing Scotland's Farming programme which are funded by the Scottish Government. These events aim to provide farmers with the skills to minimize the negative impacts of climate change and consideration of soil carbon is one aspect. Measures that are promoted in particular are locking up carbon in soils, promoting soil analysis and good soil structure management. Often these measures are more focused on tackling farm efficiencies and farm productivity by reducing waste and greenhouse gas emissions practices, than specifically focusing on soil carbon. Cover crops are not applicable in Scotland due to the late harvest period and wetter weather. Usually soil management is discussed in terms of matching the crop requirements with the best economic use of the land. Nutrient planning and management of rotations are covered under the NVZ (Nitrate Vulnerable Zones) work.

Practices that are currently promoted in Eastern Scotland region primarily relate to environmental issues and soil carbon content is usually included as a secondary topic in relation to climate change. The practices promoted relate to upland soils, carbon stocks, threats to soils, habitat restoration such as peat lands, and problems with compaction and soil erosion and the unintended consequences of restoration programmes. Also covered are issues such as nutrient management; low carbon farming; getting the best out of slurry; and basic soil analysis.

Spain

Soil management practices mentioned as being promoted in Spain relate to reduced tillage, erosion safe cultivation, catch crops, fallow fields, residue management, manure and fertilizer management, crop rotations and extensive farming, pasture, and organic farming. These practices tend to be integrated with other objectives, rather than part of a specific soil policy and there are no policies specifically related to soil carbon management.

Table 1- main types of soil/crop management practices promoted

Denmark	catch crops, crop rotations, residue management, perennial grasses and fertilizer management, including ash applications for potassium
Hungary	appropriate crop rotations, organic manure input, reduced-tillage and grass or mulch layers in orchards
Italy	cross compliance measures related to soil protection are relevant, such as minimum tillage, stubble management, crop rotation, and minimum soil cover and terracing maintenance
Poland	the types of general soil management practices promoted related mainly to cover crops, crop rotations and manure and fertiliser management
Scotland	nutrient planning and management of rotations as part of NVZ, carbon management within Farming for a Better Climate, no cover crops
Spain	reduced tillage, erosion safe cultivation, catch crops, fallow fields, residue management, manure and fertilizer management, crop rotations and extensive farming, pasture, and organic farming

2.2 How the soil/crop management practices are promoted nationally and in the case study area, including the type of information used in promotion

In all case study countries current soil management practices are primarily promoted as part of larger programmes to fulfill EU obligations, such as cross-compliance, fertilizer management programmes and agri-environmental schemes. These measures are promoted through a combination of regulation and voluntary incentives.

With respect to extension services Denmark has a well established knowledge system for connecting farmes and research, Hungary and Poland have established government agricultural advisory services while Spain relies on trade-unions and cooperatives. The case study countries described a range of promotional activities using different materials and mechanisms. Some have preferred systems for example in Denmark there is a focus on personal communication (phone/mail), meetings and press releases. In other countries, such as Hungary and Poland there is a greater focus on dissemination through literature, websites and the mass media.

Denmark

There is active communication about soil/crop management practices within the Danish agriculture sector between research, advisory service and the farmers as depicted below:
(Applied University research ↔ National Knowledge Centre for Agriculture ↔ Regional/local Advisors ↔ Farmers)

The policy makers communicate with all the stakeholders in this knowledge exchange chain, but mainly with the agriculture advisory service at the national and regional/local level.

A portfolio of methods is used in promoting soil management practices, but the focus is on personal communication (phone/mail), meetings and press releases.

Hungary

Policy makers promote soil management practices primarily through regulation, such as legislation relating to cross-compliance and the implementation of the soil utilization license. Much of the regulation relates to erosion control and nitrate pollution. Soil protection measures are also promoted within agri-environmental schemes, together with nature protection target programmes. At the beginning of the agri-environment programme awareness raising lectures for farmers were held at several places in the country and a number of demonstration events were held to promote good practice.

It was suggested that policy staff have few opportunities to promote soil carbon management practices due to limited staff and financial resources. Also due to scientific uncertainties and lack of economic incentives, policy makers pay little attention to soil carbon management which is mainly a secondary to other soil related activities.

A variety of information types are used to promote soil management practices. Literature, such as codes of practice and leaflets relating to regulations (e.g. Cross Compliance) are available. Softer tools are also used to promote soil management practices, although the extent to which this occurs varies with different regions. Authorities have pursued awareness campaigns especially in relation to nitrate pollution, with some articles published in local newspapers and agricultural journals. However, it was acknowledged that knowledge dissemination in relation to soil protection problems lags behind other environmental issues and other countries, as one interviewee noted *"A German or an Austrian farmer has more access to this kind of information".* A few conferences and meetings were held to inform farmers, especially in the introduction phase of cross-compliance and there are a few examples where it is possible for farmers to learn about soil protection measures, for example each National Park Directorate has demonstrations for orchards, but generally opportunities are limited.

Italy

Currently the cross-compliance measures represent the most active legislative tool to disseminate specific soil management practices at national and regional level. At a regional level, this tool is integrated within the Rural Development Plan (PSR). A number of initiatives are implemented to disseminate information about the rationale and legal requirements for cross compliance measures and all stakeholders from the farmers associations to the national policy maker are involved. Awareness is raised through periodical meetings, e-communication through specific websites, extension material, reports and so on. Rather than one-to-one advice, extension is carried out through specific events like meetings (e.g. workshops), thematic initiative (e.g. Earth's day) with the participation of farmers associations, advisors and policy makers.

Poland

The main mechanism for promoting soil management practices in Poland relates to cross-compliance implementation. Information on the Good Agricultural Environmental Condition (GAEC) requirements are disseminated through the website of the Ministry of Agriculture and Rural Development and also the website of Agricultural Advisory Centre which includes publications for farmers and advisors. Training for agricultural advisors and for farmers also plays a key role in the promotion of soil management practices, such as appropriate crop rotations, fertilizer management, crop protection, cultivation timings. These training sessions focus mainly on the legal requirements of GAEC and to a lesser extent on practical and technological information. One respondent suggested that publications from the last two decades differ in the scope of information provided. In the 1990s they focused on agricultural technologies, whilst since the start of the EU accession negotiations they are dominated by topics connected with implementation of the EU requirements and application for funds available under the Rural Development Plan. It was suggested that there was a significant information gap in terms of information on environmental protection in agricultural production and in publications targeted at advisors or farmers discussing the relationship between agricultural production and climate protection. One respondent suggested that information exchange with other farmers, both face-to-face and on the internet was actually a greater source of knowledge than contact with advisors.

Scotland

In Scotland, soil/crop management practices are primarily promoted through GAEC. Information is disseminated through leaflets and codes of practice. Soil management practices are also promoted through the Nitrate Vulnerable Zones programme and events related to other programmes, such as Farming for a Better Climate. The Scottish Agricultural College (SAC) produce technical notes/guides that are laminated and issued to farmers to enable them to study their soil and compare it to what it should look like. Other materials used are handbooks such as the Fen Management hand book, and TIBRE handbook (Targeted Inputs for a Better Rural Environment).

Spain

Communication channels to promote soil management practices between scientists/policy makers/advisors and farmers exist although it is difficult to assess the success of this dissemination. Trade-unions or cooperatives are the primary source of information for most farmers, and those not in these networks are often ill-informed.

2.3 Extent to which farmers and advisors are aware of, advise on and implement soil management practices with particular emphasis on soil carbon management

The extent to which farmers and advisors are aware of soil carbon management practices varied considerably between the case study countries. As soil carbon management is a relatively new issue, awareness amongst farmers is generally limited. However, in some countries, such as Denmark and Scotland there is a growing awareness of the issue, particularly amongst organic farms and large agri-businesses. Often the extent of awareness is determined by the farmer's age and farming and educational background. In contrast, in Poland not only the farmers, but also the policy makers are largely unaware of soil carbon management issues and current policy is primarily focused on meeting EU soil management obligations.

Awareness of soil carbon management practices is relatively high amongst advisors in most of the case study countries. However, in Poland it was suggested advisors are unaware of the role of farming in climate change mitigation and the need for proper soil management to increase soil carbon sequestration.

The extent to which soil carbon management practices are implemented seems to be predicated on the level of farm economic security, as many farmers (and some advisors) are unconvinced of the economic benefits. One issue affecting implementation is the perceived level of investment required to adopt these practices.

Denmark

There is generally a high awareness amongst advisors of soil carbon management practices in Demark and less awareness amongst farmers with differences amongst them. For example, organic farmers and advisors and those practicing low-tillage systems are more aware and interested, whereas farmers with high livestock numbers are less interested due to the high input of carbon through manure. Although soil carbon is recognized as an important factor for soil productivity, in general it is very rarely a subject of advice on its own as farmers invest in advice to gain economic benefits.

Hungary

The advisors are almost all aware of soil management practices due to subsidies and regulation requirements. The age, education and qualifications of the farmer and the size of farm determine the level of awareness amongst farmers. For example, those farmers who have been in farming for a very long time, "*who brought it with them as an inheritance*" are much more aware of these practices and application methods, although the younger generation farmers are generally more open to try new practices. After the transition there was an influx of new farmers without any professional experience, knowledge or agricultural tradition in the family, who are unaware of established soil management practices.

Implementation of soil management practices is often dependent on farm size, as adoption of new or improved cultivation practices often requires investment. Also farmers are not yet convinced of the economic benefits of these practices which is another constraint to implementation. For example, there are cases when a change in rotation would provide long-term soil protection solutions, but their economic situation means that they are only focused on the short-term benefits. The extent to which these practices lead to win-win (more profit with better environmental performance) situations is considered ambiguous even among the professionals.

Italy

With regard to the soil protection (including soil carbon management) issues included in the cross-compliance measures, the average awareness of the importance of such practices is limited. There is a general awareness of need to farm sustainably and a much greater awareness of the biodiversity impact of management practices than the impact on soils. For example, agri-environmental measures (e.g. crop rotations, minimum tillage for the soil conservation) are endorsed by a strong environmental awareness. Farmers' possess knowledge of anti-erosion practices, soil organic matter and soil fertility from their cultural heritage, but soil carbon management is not yet part of this heritage. The exception is the agri-quality certified or organic farms whose aim is to produce quality, environmentally friendly products even to the detriment of productivity. Older farmers are concerned about the investment costs of implementing new practices, whilst the young farmers are more disposed to acquiring information about soil erosion, pesticide use, minimum tillage etc.

The level of awareness amongst advisors is dependent on the environmental interests of both the regions and the professional associations that train the advisors. It was suggested that advisors lack information to fully advise farmers on the economic impact of adopting soil management practices. It was suggested that in the future farm advisory services are likely to receive EU support, in which case their services will have to broaden from simply advising on cross-compliance measures to more detailed information about environmental issues.

Poland

The respondents claim that advisors are aware of the need to implement good soil management practices. However, this knowledge refers only to the practices that can increase production efficiency or that are required by legislation (e.g. GAEC, agri-environmental schemes, requirements for nitrate vulnerable areas, etc.). The interviews show that advisors are unaware of the role of farming in climate change protection and the need for proper soil management to increase soil carbon sequestration. They claim that these issues are not raised during the training for advisors and therefore are not discussed with farmers. According to policy makers, farmers know little about environmental protection and nearly nothing about climate protection needs. The interview responses also suggest that the policy makers also know little or nothing about these issues.

Opinions on how farmers apply soil management practices varied. Some felt the extent of implementation was limited, particularly amongst the older farmers that produce for their own needs or for the local markets. Profit maximization is a driver, with for example farmers ignoring crop rotation requirements. "Only *one type of crop can be cultivated on the same land for a maximum three years – in order to bypass this requirement after three years of wheat farmers cultivate barley or rye for one year and then come back to wheat*". Another felt that soil management practices were adhered to under agri-environment schemes and for organic farming due to concerns about loss of payments. One felt that farmers do "*try to implement the requirements*". Their success in this area depends on the economic situation – during a crisis they are more willing to apply improper measures. He refers to meadow and stubble burning as an example – although illegal, it is still practiced.

Scotland

The extent to which farmers and advisors are aware of and implement soil management practices varies across Scotland depending on the context and the individual farmer/advisor. Some farmers will be very knowledgeable, whilst others will be very difficult to reach or resistant to using modern technologies due to cultural and future planning issues. Soil carbon management is quite a new management issue in Scotland and unless farmers are already using in-depth soil analysis they are unlikely to be aware of implementing such practices. Policy makers are surprised by the number of farmers not conducting soil analysis, let alone considering carbon management. The sector, size of farm and age of farmer will also be a contributing factor in the level of awareness and implementation. Generally, the larger agribusinesses are likely to have a greater awareness of soil management practices and regulations as they tend to have more contact with advisory services. The smaller farms are likely to have a more intimate knowledge of their soil on their land, but will be less aware of the current regulations and debates.

Generally it is thought that the level of awareness of the importance of soil health is very high, however, having knowledge of everything that needs to be considered is unlikely. There is more awareness of buffer strips and grass margins to slow down and catch

sediment, due to a campaign driven by the Scottish Government, offering one-to-one walks to discus suggestions for reducing sediment run off.

Spain

It was suggested that generally farmers in Spain lack knowledge of climate change and even less so of mitigation practices even though the effects are already being seen. The extent of advice on soil carbon management is also limited. As one advisor acknowledged 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 as the practices are too complicated. It was suggested that communication to the farmers is not necessarily the issue, but more importantly, is to agree and display some clarity on "best practice.

Respondents suggested that farmers in Spain are interested in new information and practices but purely from a point of view of improving their productivity, i.e. any new soil management practices would have to be presented as economically viable. They are conditioned and often limited by the characteristics of their environment (type of soil, local climate, availability of water etc).

2.4 Main barriers/incentives to the uptake of soil management practices

2.4.1 Main barriers to the promotion and uptake of soil management practices

One of the main concerns expressed by interviewees in most of the countries was the perceived scientific uncertainty about soil carbon management. There is a sense that scientists themselves do not yet fully understand soil carbon dynamics and interviewees feel that it is only when there is agreement amongst scientists that practices recommended will have credibility. Interviewees mentioned the debates about the efficacy of different practices for sequestering carbon and for enhancing productivity and the fact that there is no consensus about what is the best practice for storing carbon under certain conditions; also that systematic assessment of different practices was missing. Related to this is the lack of evidence or real examples and the difficulty of demonstrating of the positive effects of soil management practices and economic benefits over a long time scale. The issue of geographical heterogeneity and the need to be aware of different areas and different practices both within countries and across Europe was also raised by interviewees in Spain and Italy. The problem of identifying appropriate measures at the farm scale was also identified. Lack of integration with other policies and regulations and good joined up advice was a further concern. . In Spain alone tenancy was mentioned as a barrier.

There were also barriers identified related to farmers' perceptions and priorities. *S*oil carbon management practices are often perceived as uneconomic, impractical or expensive to implement because they require investment in new technology. Lack of knowledge or familiarity with practices compounds this. There are a lack of financial incentives or subsidies and when practices are part of agri-environment schemas the prescriptions are too rigid and farmers do not want to risk non-compliance. Also commercial imperatives often override good practice, demands from the market either through prices or contracts with retailers can override good practice intentions. Linked to this commercial companies and advisors provide production oriented advice which can contradict 'good practice' advice.

Denmark

As in other case study countries there was a perception of scientific uncertainty about soil carbon management. One advisor said '*the cause and effect relationship between soil carbon and yield seem to be lacking or very theoretical'*. Another barrier identified for soil carbon

management is the timeframe and the difficulty in demonstrating the economic benefits to the farmers. Furthermore soil carbon is still a relatively new issue for most farmers and they are not used to thinking of this as very important. A limited number of catch crop varieties like yellow mustard was also identified as a barrier.

Hungary

Scientific uncertainty was described by policy makers as one of the main barriers to changing soil management in Hungary and systematic assessment of different practices is thought to be missing. Advisors point to lack of subsidy for supporting new practices as the main barrier. With respect to advice there are several commercial companies and trading networks that convince advisors to recommend their products, and this might not support soil carbon protection. Facilitating new soil practices is not the role of these commercial services which are concerned more with inputs and machinery. With respect to farmer uptake larger farms have more room to "risk" something new while arable farms seem to be more flexible than other permanent crop or livestock farmers. Farmers are concerned most with complying with cross compliance regulations and are keen to avoid sanctions with fine or subsidy loss.

Italy

Farmers have built their own experience and local knowledge of different practices in their farms over time and use this effectively so they are reluctant to take up new unfamiliar practices. In this context, economic incentives or sanctions would be an important motivation. According to the advisors interviewed acceptance both of the idea and adoption of the practice are related to economic feasibility. Lack of evidence or real examples of the positive effects of such practices again was mentioned with particular note of the difficulty of demonstrating long term benefits – even for a a good advisory service this is a challenge. One advisor stressed that the absence of information was a barrier and suggested that a tool that would able to compute the technical-economic damages of not implementing a practice would be helpful for advisors. One advisor suggested that potential technical problems in the application of specific measures should be addressed with a specialist consultants. Another barrier mentioned was the farmers' difficulty in integrating practices into their farm management system, one advisor added '*information too specific (i.e. soil carbon) and communicated as an isolated issue is doomed to failure'*.

Poland

The interviews suggest that low environmental awareness and very low awareness of climate protection needs constitute the main barriers to implementation of soil carbon management practices. According to one respondent, low profitability of the agricultural sector and low education of a majority of Polish farmers are also significant barriers. Due to the poor economic situation in many agricultural holdings (and the long tradition of free advisory services), the majority of farmers use free public advisors and not commercial advisors. However, the poor financial state of the agricultural advisory system means that the quality of advisory services is poor. Farmers are not motivated to implement soil management practices and do not look for information about them as soil carbon management is not perceived to have a direct impact on farmers' profits.

Scotland

One policy maker suggested that farmers are aware of the importance of soils but that it is the market drivers that pull and orientate the farmers and as a consequence they do not always do what is best for the soils. Fluctuations in the markets which are a barrier to the uptake of soil management practices are more prevalent now than in previous years. An

example of commercial imperatives overriding good intentions and practices is in the harvesting of high value vegetable crops such as carrots in inappropriate weather to meet supermarkets demands which causes soil compaction.

Regulations and agri-environment scheme prescriptions are not always compatible with beneficial soil management. Funding processes for schemes were also mentioned as a big hindrance, as they tend to be difficult or schemes do not include the right options. One advisor suggested that restrictions can impact soils productivity such as not being able to plough land before March 1st (he argued that ploughing the land earlier allows nutrients to be broken and results in more productive crops while ploughing later leads to more costs through higher diesel usage as land has to be ploughed multiple times to produce same quality land to sow). Also regulations restrict when farmers are allowed to cut grass which is not necessarily the best for optimising carbon sequestration. Currently uncertainties in CAP reform debates are causing farmers to pre-empt rules and plough up land which has been untouched for decades. Another issue raised in Scotland was that farmers are unable to plant cover crops due to a weather related late harvests, this practice is therefore not available to them.

Spain

In Spain interviewees identified the government's lack of knowledge of 'the real world' and the tendency for government knowledge and action to be based on something political rather that scientific as a barrier to implementation. It was also noted that the attempt to transfer scientific knowledge into policy is and will continue to be a major barrier to mitigating climate change. Another communication gap was identified between the science and practice, one advisor said:

> *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, think this will be fairly ineffective. Have to break down barrier 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 practices defined will be so far removed from current practice that they won't implement it.*

A key barrier identified was the uncertainty and on-going debate about suitable practices, for example in the workshop held in Spain as part of this consultation there was non consensus among the experts about the mitigation and productivity impact of leaving fields fallow. Interviewees agreed that it is necessary to study all types of farming systems and find the appropriate practices for each one but that currently systematic assessment of different practices is missing. As one advisor commented '*The scientific community is not yet in agreement and it will be difficult to achieve. Lacking concrete analysis all over Spain, let alone Europe and globally. You cannot just walk up to a farmer and tell them to change their practices without any kind of incentive*'. Also past experiences of scientific recommendations have not always been effective and this can effect the acceptance of new knowledge. It was also stated by multiple respondents that for Mediterranean and semi-arid climates there is a lack of consensus on "best practice. Although mitigation measures already exist it was considered that there is no concrete process for tailoring them to the specific requirements of each farm. At the field level often the advisors are not clear about what to recommend, as mentioned above in section 3. There is also the issue of regional and farm level diversity '*You have to be aware of different areas and different practices. What might apply to one farm will not be appropriate for another'.*

Farmers' lack knowledge of climate change and even less of mitigation practices and the production systems with soil carbon management may get/or seem to get more complex to manage and this will deter farmers. One interviewee commented that farmers do not know scientifically why they do what they do and so this lack of technical knowledge is another barrier. Also a sense of personal responsibility about climate change is low even amongst well educated/environmentally responsible farmers. Tenancy was mentioned as a barrier since the number of tenant occupied farms is relatively high in Spain and thus any measures implemented have to consider who will be the principal beneficiary.

2.4.2 Main incentives (and actions required) to encourage uptake of soil management practices

Most interviewees agree that currently farmers do not care enough about climate change to adjust their practices without financial incentives - either as subsidies or proven financial gains from the practices. It was universally agreed that demonstrating the benefits of investing in soil management, the financial gains of soil analysis and how it can improve farm profitability and productivity are thought to be good incentives for encouraging uptake important. Only a few respondents mentioned regulations or sanctions while most partners suggested improving advisory mechanisms, simplifying the message and using the right language, targeting advice and making it appropriate at the farm scale. With respect to achieving better uptake there is agreement that there needs to be a better understanding of the processes and more confidence/less uncertainty in the results and practices recommended before farmers are approached and that scientific clarity on "best practice is very important.

Denmark
Respondents agreed that clarity was important in advice to farmers, as one said '*What 'we believe'* is not enough for the farmers. Farmers need evidence that a certain change/practice will either increase output or bring other benefits in terms of savings. There is also a need for precise crop specific information on carbon accumulation. Policy instruments and regulation were also suggested as tools for enhancing adoption. A need for visual evidence that practices benefits soil health, are cost effective and enhance crop yield was recognised since farmers often feel a sense of impunity, as emissions are "invisible" and personal responsibility is absent.

Hungary
At the moment in Hungary most of the "innovative" practices are subsidy driven, in which agri-environmental measures are dominant so soil practices would need to integrate with these Respondents in Hungary also reinforced the idea that successful examples and real life demonstration are important in promoting acceptance. They agreed that more practical demonstrations and test fields (with control strips), where farmers have the opportunity to "experience" and observe the results/differences are needed. Although different information channels – such as books, leaflets, internet, etc. – are useful, personal/neighbors' real life experience is thought to be more powerful. With respect to regulation and standards one respondent said that they had to enforce the standards but these unfortunately have been too general and do not adequately serve the purpose of soil protection, environmental protection or nature conservation. They suggested further control and regulation in this field.

Italy

One policy maker suggested that communicating with the right language (in terms of type of information and format) was important when talking to farmers. Also that it is important to take into consideration the new farming generation who may not have the same 'cultural heritage' as the old farmer generation. Providing information was regarded as important such as technical aspects on how to implement new practices; - economic quantification related to the investment and to the damage due to the no-application; statistical data on the possibility that negative events can occur whether the practice is not adopted (e.g. with a crop rotation with a time span of 3 years, the probability of specific pathologies is by 50%). Some believe that the effectiveness of cross compliance with the threat of possible sanctions is an effective approach although accept that sanctions are not always dissuasive. One policy maker suggested that usual approach (command and sanction) about an environmental measure should be integrated with technical information directly communicated by the advisors to the farmers.

Poland

Some considered that wider implementation of these practices would necessitate their promotion under one of the agri-environmental schemes. Another solution proposed was to introduce regulation. However it was pointed out that some farmers already violate legislation or the requirements of good agricultural practice when seeking profits. Again it was suggested that demonstration visits would constitute the most effective promotion tool. Interviewees claim that farmers usually distrust theoretical information but are more open to solutions that have already been tested by other farmers and when they can become familiar with their effects.

Scotland

One advisor considered that it was not always necessary to incentivise by offering financial support, he suggested that sometimes clear demonstration that something will improve farm profitability is enough incentive. However, some farmers raise practical issues and say 'well that wouldn't work on my farm', or 'I can't work it out'. A Scottish policy expert agreed that the financial side is a strong an incentive saying '*that's why we called our event 'Soil, Muck and Money'! To get people interested and involved, looking at what you've got and making best use of it combining this with your soil nutrient budgets* etc.

With respect to financial incentives barriers tend to be the sources of funding and delays/difficulties in the application process, for example funding for grass/buffer strips available through the SRDP has a 50% success rate and is a long process. One advisor suggested that a better approach would be for every farmer is allocated money that he could utilise as he sees appropriate. Tailoring funding, making the application process easier would encourage farmers. However one interviewee pointed out that the cost and bureaucracy linked to incentive schemes could in itself be a barrier.

With respect to advisory mechanisms SEPA in Scotland no longer use mailshots to advertise changes in regulations. They are reliant on the press and web, but the chances that a farmer will look on the SEPA website are very low, also some farmers are not SAC members. Only the 'usual suspects' ie farmers already engaged will attend keep up to date, workshops and demonstrations. Local farms scale advice is thought to be important as it can target individual farm conditions and farmers and develop a programme of work for the farm and the particular issues. With respect to the message 'big' issues like climate change need to be condensed down into an easily understandable way. Farmers are very time-poor (an additional barrier) so to get their attention headlines need to be attractive and understandable to first increase the level of awareness (barrier) before uptake will happen.

In this respect the branding of DST tools is also important if they are meant to be used by farmers – they have to have a farmer friendly name. The delivery of the tool is extremely important –distilling the information down into an easily digestible format such as 'knowledge scotland' is the key to reducing the barriers.

Spain
One advisor suggested that mitigation measures must be seen as economically advantageous and will be more effective if seen in terms of possible savings or losses of income, rather than explicit incentives or fines, one commented '*If the messages we want to communicate do not convey economically viable ideas, then they will be worthless'.* Another felt that adjusting practices in light of climate change would be considered a public interest and as such it will be necessary to introduce monetary incentives/fines to incorporate mitigation measures, he said: '*Farmers are predominantly motivated by economic actions and decisions and have a relatively short-term outlook. If it brings additional mitigation benefits, then that's a bonus but not the primary motivation.'*

Some argued that communication to the farmers is not necessarily the issue, more important is to agree and display some clarity on "best practice". There was a wide belief held that it is essential to simplify the information in order to communicate a complex message to local situations. One suggestion was that if farmers were made aware (through education) of the carbon cycle, they would be less inclined to employ bad practices and that only once they have a good scientific knowledge base, could they start to include mitigation methods.

2.5 Information used to design soil protection measures and practices, the format in which this information is available, gaps in knowledge and the level of confidence in the data

Different respondents identified different sources which were relevant to their work and which they were familiar with. Most countries reported good information sources although in Hungary interviewees said that available data is not up-to-date and often not complete, likewise in Italy maps and database were described as often outdated with a lack of integration and with different levels of details. Confidence in maps and data was questioned in some countries including Scotland where fields are being constantly remapped.

Denmark
A broad range of information sources are used. Soil texture analysis, presented as GIS systems/maps, is a common tool for giving precise advice on liming but also fertilization. Scientific reports are used in many aspects – especially very applied-oriented scientific reports giving evidence for direct and simple cause effect relationships. Also practical experiences from farmers are given due importance and taken into account.

Hungary
Different soil property maps are used, however their scale and scope are not always appropriate. Most of the available data is not up-to-date and often not complete. The information are not coordinated in a suitable manner. Integration of different sources would benefit the system to a great extent, but lack of financial resources hold this back. New initiatives are usually unable to persist for longer period, again because of financial constraints and incentives.

Italy

- Information used: scientific research, regional and national maps (soil, organic matter, risk of erosion, desertification, etc.), soil database (40000 soil samples - information is based on several years of soil analysis) and European regulation.
- Format: maps, database and geo-database, documents, scientific papers disseminated by means of website, reports, workshops.
- Sources mentioned vary depending on respondent, they include : agronomic know-how provided by National and Regional Research Institutes and University (provides scientific knowledge to fit the measures to specific issues of territories); AGEA-SIN is a widely used tool based on its database, and this provides information about applicability and controllability of a potential measure; CRA and the National Rural Network (RRN) in which other National Institutes like INEA and ISMEA are involved.
- Gaps in Knowledge: maps and database are often outdated. Soil measures are subjected to an ex-post scientific evaluation rather than an ex-ante one. Lack in the integration of the existing informatics systems. Limited information about specific environmental aspects at national level; the different level of detail of the information provided by the Italian Regions; outdated information at national level; overall there is a the lack of a complete and homogeneous overview (picture) of a specific environmental aspect at National level; -
- Lack of an effective language, which hampers the use of the DSTs by stakeholders. The information is easily used and is open to different interpretations.
- Level of confidence in the data: different levels of detail of the information among regions.

Poland

A broad range of information sources are available: soil guidelines, fertilization applications scientific reports, soil property maps etc. Some of the existing data are not updated and not complete. The information are not coordinated in a suitable manner. Access to some of the data limits their commercial character – payment is needed for access. Availability and content of the existing information also depends on the region - in some parts of Poland more information exists than in other. There are on-line maps available on the portal of the Mazowieckie Voivodship Office which contain information on e.g. soil quality, humus content, pH, vulnerability to pollution. These maps help advisors in decision making.

Scotland

Scotland hold an extensive coverage of soil data and derived information provided by the JHI (formally MLURI). There is a wide range of information and evidence on the state, threat and pressures faced by Scottish soils (state of Scotland soil report 2011) and an extensive program of research by RESAD to fill the gaps on quantifying threats and option to response to threats. There is also a soil monitoring action plan being developed by CAMERAS. A soil portal (Scottish Soil data web) project lead by Scottish Government is in progress and will provide better access to soil information in future. The SEWEB (Scottish Environment Web) already provided link to extensive information.

Maps are valued and are used in SEPA's river planning database and SNH's designation database. Soil risk maps are used for identifying different parts of the farm and the individual characteristics of the farm to come up with a relatively qualitative risk rather than quantitative, like slope, permeability of the soil, water courses. Issues regarding data are a concern as Scottish Government continually remap the farms and renumber the fields, this makes it difficult to identify the correct field in an analysis and leads to a high level of uncertainty.

Spain

The respondents report good datasets in Spain. The policy makers remarked that a lot of information is derived from national experimental centres (INIA, CSIC) which have varying types of experimental farms and argued that the data and research produced was of a high quality. (It was also commented that experimental farming is essential in Spain and should be supported with public funds more since in the areas surrounding the experimental centres, there is increased uptake of new practices based on the results of the studies.)

In addition to these national centres, information used to design soil protection measures is also derived from collaboration with universities and private/public research centres, agronomic associations, trade unions and cooperatives. There was some discussion amongst respondents on the lack of collaboration between different scientific sectors (Soil, water, pests….) and they concluded that the data is of high quality but the lack of transfer between scientist and policy makers impacted the quality of the final measures and practices defined.

3. Analysis of usage of decision support tools and preferences regarding the SmartSOIL DST

In this section, the results of the questions relating to the current usage of decision support tools and preferences regarding the SmartSOIL tool are summarized.

3.1 Current uptake of DSTs

The degree of experience with and the frequency of uptake of DSTs vary by country as well as within actor groups. Overall, DST usage appears to be limited. The relevance of DSTs for farm level decision-making based on this initial consultation is difficult to judge as it was not possible to determine the actual frequency of use or the role of DSTs in motivating farmers to employ new practices. Nonetheless, the consultation shows that the uptake of DSTs among farmers and advisers appears to be primarily dependent on four factors: (1) relative novelty of DSTs and their emergence only within the last 10-15 years; (2) production orientation and farm size; (3) financial constraints and level of computer literacy; and (4) the impractical, overly complex nature of available DSTs.

Regarding the first point, the tendency to rely on personal experience and established knowledge rather than automatically instill trust in ‘new’ tools was highlighted. Advisors in particular have consistently lower uptake of DSTs due to their specialized knowledge of their land and the issues addressed by available DSTs. Uptake within this group is therefore often dependent on the DST proving its worth over time via positive experiences and reviews amongst farmers.

Moreover, variations in uptake are also linked with the size or orientation of farms. Hungarian respondents suggested that professional farms and most advisors generally use computer based DSTs (usually in the form of excel worksheets), while only about 30-40% of farmers as a whole utilize these tools across the country. A UK-based advisor emphasized the role of production orientation of farms in the following terms: “Arable farmers are more cut-throat intensive industries which are more likely to be at the forefront of technology use, whereas the extensive livestock farmers don’t have the need as much so tend to plod along as the divide between the top end and low end is bigger than in the more intensive pig, poultry and cereal industries.”

Three types of financial constraints were pointed to as limiting current use of DSTs. First of these constraints is the lack of internet and computer access linked with limited computer experience. While software and online decision support tools are often available in the case study countries, they are often not effective for communicating messages given that many smaller villages are not connected to the internet. For those who have access, the target population was cited as not being IT-savvy enough to be aware of and use the online resources and tools as intended. Secondly, high purchasing prices or privatized nature of the DSTs was also raised as an issue limiting the accessibility of some tools for wider audiences. While high quality, issue specific tools do exist in many countries, they are sometimes privately owned and therefore not available to the public domain (e.g. supermarkets in the UK each have their own carbon accounting tools). Thirdly, financial constraints – in addition to holding relevance for individual farms – were also raised with regard to the maintenance and upkeep of DSTs. In Hungary, for example, potential users express skepticism about long-term financing, operation and updating duties. While appropriate and credible DST would be desirable, the lack of detailed and up-to-date data sources in light of the large spatial variability of the subject matter result in certain users avoiding DSTs. The fact that different stakeholders are interested in different issues was further cited as leading to the need for integrated, complex tools which, again, are viewed as being too expensive or challenging to realize and maintain.

The final point raised by the majority of respondents is the impractical, overly complex nature of available DSTs. This was the most frequently cited reason for not using. Complex tools require large time commitments and an advanced knowledge base to arrive at the desired outcomes. As a result, policy makers more frequently avoid using DSTs and instead rely upon researchers for using the DSTs and summarizing the findings (for example, in the UK). This is also the case in Hungary, where farm record systems are too complex for farmers and are instead only utilized by experts in the field (e.g. accountants, computer specialists, etc).

Simplification and practical applicability and usability of tools is thus key to their success and relevance. Efforts to simplify DSTs have already been made e.g. in Denmark in that the majority of tools are developed or facilitated by the National Knowledge Centre for Agriculture and are created in cooperation with university researchers, advisory service representatives and farmers (although advisory services play the largest role). Polish efforts to address this shortcoming consisted of developing trainings for agricultural advisors and creating a help desk to provide assistance to advisors when they lack knowledge on a particular subject.

Concerning the DST development, Italian and Spanish respondents encouraged the involvement of farmers in the entire process. A DST should be submitted to a test period by its potential users to assess effectiveness. Ultimately, stakeholders should then also be involved in the finalization phase in a collaborative process. This will not only ensure that positive features are included within the tool, but will also increase the trustworthiness of the tool by the intended user groups. Finally, there should be a degree of flexibility in the DST development to ensure that improvements proposed by users during its use can be addressed and integrated into updated versions.

3.2 Formats, features and examples of available DSTs

In the consultation, interviewees were asked about what formats, features and examples of DSTs they find particularly useful. While the majority of respondents acknowledged the

difficulties in creating an 'all-encompassing' tool catering to the different needs of policy makers, farmers and advisors, strong response patterns nevertheless emerged regarding both desirable and ineffective features and formats of DSTs. Characteristics of the target user group such as age, socio-economic situation and nationality must be integral considerations in tool design. Additionally, respondents also provided us with an array of examples of currently used DSTs (see Tables 2 and 4).

3.2.1 DST Formats

Preferences regarding the DST format differ according to age. Four of the six countries highlighted the differences in format preference between differently aged farmers. Older farmers generally prefer written formats over phone applications, computer programs (e.g. excel) and web-based tools, while younger farmers are also comfortable with the newer technological formats. The benefits and drawbacks of these and additional formats are numerous and described below.

Regardless of age, *printed materials* are prioritized in all represented countries. According to a Scottish respondent, "hard copy technical notes are still the most useful as they are tangible and familiar to farmers and can be discussed with an advisor in the field". Think Soils, for example, is guidance manual developed in the UK which is praised for being printed on water proof paper, is pictorial and outcome focused. Yet, there is also the risk of overloading farmers with leaflets, perhaps deterring them from investing the time to read new materials.

Online or computer tools, unlike printed materials, offer flexibility and allow the possibility to be regularly updated. However, "although the online formats are the best way to get information, their effectiveness is related to their accessibility and to the kind of information provided" (Italian advisor). Such tools also run the risk of excluding or alienating those individuals who lack IT knowledge or internet access, as mentioned by half of the respondents.

Given these often polarized views, the difficulty in addressing all opinions within a single tool becomes evident. This was nicely summarized by a British advisor: "It seems to be that we're stuck - with everything you come up with there's a reason why it's not very good. You talk about postal or leafleting guidance direct to farmers and people complain about getting too much through the door, so you put things on the internet and people say, 'well we don't actually use computers'." Taking these considerations into account, an integrated approach with both online and paper-based options could be ideal. This standpoint was iterated by an Italian respondent: "We use leaflets to focus on specific aspects, with simple technical explanations and a set of practical rules. In order to get more details, an online periodical is related to the leaflet."

Additional formats were mentioned with more divided opinions. *Recommendation tables*, for example, were believed to be useful if simplified and created per farming system type and to illustrate the interactions between different parameters (e.g. productivity, sequestration, adaptation aspects, and other ecosystem services). However, these tables require extra interpretation from an advisor. Such a format could however be useful for politicians as they provide clear, definitive answers. *SMS services* or *the use of smart phones* were recommended by several of the Danish, Polish and Italian respondents, but discouraged within the context of older farmers. Approximately half of the respondents preferred an excel format (e.g. for wheat cultivator, nutrient balance, cost comparisons) –

including Denmark and Hungary – while others discouraged this approach due to the time investment and high level of familiarity required to successfully input data.
The use of *maps* were supported by all countries (and in particular by the policy makers), but were encouraged to "be used as a guide, not a gospel. They have great value, but must be used in conjunction with something else or by someone who understands the constraints and opportunities of maps" (British policy maker). Agricultural online maps were framed by a Polish respondent as having the potential to support rational decision-making, such as distribution of funding for soil reclamation or liming.

Finally, approximately half of the countries supported the idea of offering *one-to-one advice* from advisors, either on the farm or via workshops. A Hungarian policy maker shed light on his country's model of having a farmer forum where farmers receive advice on how to cultivate the land. Such an arrangement is supported by personal visits on the farms (up to twice a year in the spring and fall) where they can inspect the situation on the farms in different seasons. "Farmers can take a look at the farming devices and learn how and why to use them." Within such a venue, the content of the decision support tools (brochures and studies) and practical considerations are discussed together. Such an approach would additionally help to address the typically "passive character" (Polish advisor) of DSTs, in that they frequently focus on distributing informational materials rather than talking with the farmers to help them understand the information presented in the publications.

3.2.2 DST Features

Several features emerged as being crucial to producing effective DSTs. In all countries, respondents emphasize the need for a *user-friendly and concise interface*. Other shared ideas refer largely to the input of information and presentation of results, including simple, straightforward, easy-to-use, time efficient and accessible (referring to being cheap and available). Several respondents underlined this theme, emphasizing that tools should be "straightforward to get the answer one needs" and should aim for a "practical application, rather than being an academic exercise". An Italian advisor emphasized that a useful tool should be conceived so that it provides supplementary information (more than the handbooks) and excludes technical information that is not relevant for the final decision. This would assist in relieving advisors of the information elaboration phase, which is time consuming. Ultimately, the key is to distill the desired message down into an "easily digestible format" as done by, for example, knowledgescotland (UK policy maker).

Personalizing tools for different farms and farm systems was also raised as an important feature by half of the countries. Implying a level of desired detail and specificity, one respondent believed that there should be the possibility for farmers to *personalize technical* information (i.e. simulating the practice in the context of their own farm and to evaluate the implications). This additionally includes taking account of such aspects as livestock breeds and historical factors of the land in question as well as being sensitive to a range of parameters deemed relevant to the individual farm. Current weaknesses in this area with available DSTs were raised by a British policy maker, stating: "Tools and models are too complicated. The more precise measure you want, the more complicated the model. Most DSTs are not precise enough at soil level to provide the sort of recommendation that farmers wants. Most models don't have a feel of accuracy of history of land to provide that level of detail" (UK policy maker).

In addition to the appropriate level of detail, another consideration is what level of comprehensiveness is needed to offer useful insights: "An effective tool should cover more

aspects of each analysed issue. For instance in the case of the furrows or the soil fertility in the cross-compliance measures, the normative information must be followed by technical information that allows us to define different solutions in different farm situations (case studies, examples). This would help the extension and the understanding of the practices" (Italian advisor). Currently, many existing tools were cited as being overly simplistic, thereby rendering the end results worthless. In short, a DST must balance simplicity for the user with accurate results (complexity) and ease of use.

3.2.3 Thematic coverage of DSTs

Numerous examples of DSTs are currently in use in different countries, covering a range of thematic areas. However, while the individual topics vary, the focus of these tools and priority of users rests on practicality and maximizing economic profitability. The main topics covered and respective countries are listed here:

- Prognoses for grazing (Denmark)
- EU legislation (including GAEC) (Poland, Italy)
- Harvesting of silage (Denmark)
- Irrigation management (Denmark, Hungary, UK, Italy)
- Crop disease control (Denmark)
- Weed control (Denmark)
- Pest control (Denmark, UK, Italy)
- Erosion control (UK, Italy)
- Runoff (UK)
- Nutrient management plans (Hungary)
- Carbon soil management (UK, Italy)
- Optimal fertilization (Denmark, Poland, Italy)
- Soil compaction (UK)
- Liming (Denmark)
- General information on crop-specific management (Denmark, Poland, Italy)
- Green accounts (nutrient balance/energy) (Denmark, UK)

DSTs for carbon accounting are used primarily in the UK, in particular CALM and similar tools were mentioned. Currently, the Soil Association is developing a carbon toolkit which is built from existing tools, but was cited as not picking up changes in management and being 'crude'. In Hungary, respondents clearly stated that farm carbon calculator tools are not used, although a few initiative attempts took place as a result of EU requirements. No DST on soil carbon or soil structure was known by Danish respondents and Polish DSTs were said to provide "insufficient information on carbon soil management in the context of climate change". In Spain, a national project is ongoing in Cordoba with the aim to develop a carbon footprint calculator for different types of crops.

Examples of available DSTs as well as a brief summary of their positive features (where provided by respondents) are outlined in Table 2 below. Additional DSTs which were

mentioned but which are also relevant for potential integration with the SmartSOIL tool are outlined in Table 4.

Table 2: Available DSTs by case study country

Tool name/link	Description	Positive features	Country
Huella de Carbon Calculadora	Carbon footprint calculator for every type of crop		ES
TERRANO tool	Assess effects of machinery use on soil compaction down the soil profile		DK
C-tool (http://www.agrisci.dk/c-tool/)	Enhance SOM model development by aiding the construction, revision and testing of soil carbon turnover models		DK
DLBR (http://it.dlbr.dk/DLBR_IT.htm)	Comprehensive database stored on cropping history, input, soil data etc. for individual farmers	Complete farm plan	DK
Markonline		takes soil types into account; new and more advance/accurate; complete farm plan	DK
Farmscoper (http://www.adas.co.uk/Home/Projects/FARMSCOPER/tabid/345/Default.aspx)	Used to assess diffuse agricultural pollutant loads on a farm and quantify the impacts of farm mitigation methods on these pollutants. It also determines potential additional consequences of mitigation method implementation for biodiversity, water use and energy use.	user friendly; gives the farmers financial benefits of employing measures and quantifies the saving for the farmer; includes ELS data to provide up-to-date picture	UK
RB209 (http://www.defra.gov.uk/publications/2011/03/25/fertiliser-manual-rb209/)	Defra's fertilizer guide (guidance and recommendation tables)	Paper-based	UK
MANNER (http://www.adas.co.uk/MANNER/tabid/270/Default.aspx)	A software tool which predicts the plant availability of manure nitrogen (N) following application to land.		UK
Sundial (http://www.rothamsted.ac.uk/aen/sundial/sundial.htm)	"SimUlation of Nitrogen Dynamics In Arable Land"- dynamic computer model of nitrogen turnover in the crop/soil system		UK
Well-N (http://ecobas.org/www-server/rem/mdb/well_n.html)	Model for sustainable use of nitrogen fertiliser		UK
CropKare (http://www.farming.co.uk/tools/willetts/)	Fertiliser recommendation crop calculator		UK
CALM (http://www.calm.cla.	"Carbon Accounting for Land Managers" - business activity-based calculator showing	Simple, internet based, provides	UK

Tool name/link	Description	Positive features	Country
org.uk/)	the balance between annual emissions of the key Greenhouse Gases (GHGs)and carbon sequestration associated with the activities of land-based businesses.	choice at the end. Companies developing it have done customer insight, designing systems for people in mind.	
Planet[1] (http://www.planet4farmers.co.uk/)	Nutrient budget control; about climate change, profitability and diffuse pollution		UK
Farming for a better climate (http://www.sac.ac.uk/downloads/120175/farming_for_a_better_climate)	About climate change, but addresses farm efficiencies, slurry use and targeting with fertilizers to maximize return per unit	Farmer focused	UK
LADSS (http://www.macaulay.ac.uk/LADSS/dss_home.html)	"Land Allocation Decision Support System" - Collective term for a farm-scale integrated modelling framework that is being developed to simulate whole-farm systems.	Produce booklets	UK
Agricultural benefits spreadsheet calculator	DST to help staff decide whether waste can be applied to land, without causing harm - without excessive loading of metals to soil. It uses RB209 and Sludge Use in Agriculture (Guide) thresholds for toxic elements, so is concerned with nutrients, lime and contamination risk. The 2 documents are combined into a simple spreadsheet as a tool for staff.		UK
Think Soils (http://adlib.everysite.co.uk/adlib/defra/content.aspx?doc=263232&id=263233)	Manual to help staff identify soil and management options to reduce damage; primarily for EA staff and external advisors, not farmers	Every copy gets distributed with a feedback form; printed on waterproof paper; pictoral; focused on delivering outcomes	UK
Sediment Matters (http://evidence.environment-agency.gov.uk/fcerm/en/Default/HomeAndLeisure/Floods/WhatWereDoing/IntoTheFuture/ScienceProgramme/ResearchAndDevelopment/FCRM/New.aspx)	Aims to help non-specialists understand sediment sources, pathways and stores so that they can collect the evidence necessary to support procedures such as land drainage consents and anti-pollution works notices and identify sustainable sediment management solutions for their catchment.	Hard copy; includes a series of risk assessment stages	UK
Allowance tool (http://web1.adas.co.uk/alowancehome/)	Map-based software tool that looks at the capacity of land to accept materials such as slurry or agric wastes, at constraints	available externally, there are 2 levels, public facing and	UK

[1] Received many negative reviews from UK policy makers.

Tool name/link	Description	Positive features	Country
	like NVZs. it's a decision support tool, for example if a farmers was planning to put in an AD they would use this tool to help with positioning and planning.	specialist user group which uses the data in more detail	
Gatekeeper (http://farmplan.co.uk/software/crop-management/gatekeeper.aspx)	Can help manage field records, crop records and stock records. The software can be used to plan for future seasons; monitor margins; review and compare input costs; and look at trends over a number of years.	Good interface; uses PLANET in the background	UK
Tried and Tested (http://www.nutrientmanagement.org/)	a booklet with principles of nutrient management and a spreadsheet at the end; the same as PLANET but paper based	Paper-based	UK
Knowledgescotland (http://www.knowledgescotland.org/)	Online resource for policymakers and Government stakeholders that is focused in the food, health, environment and rural sectors.		UK
Public Good Tool (http://www.organicresearchcentre.com/?go=Research%20and%20development&page=Resource%20use%20and%20sustainability&i=projects.php&p_id=20)	Excel-based tool developed by the Organic Research Centre to assess the public goods provided on a farm. Only used by advisers (not for public use).	Follows a holistic approach	UK
Soil Catalogue	based on a database that collects about 30 years of soil information of both geological (geological surveys) and agronomic (soil features and subsoil fauna) nature	Farm scale; built with the idea to provide the users with an interactive DST, which based on a sound database allows to personalize all provided information	IT
FERTIRRIGERE	provides information on irrigation and fertilization	Information provided to the farmers through sms	IT
MiPAAF	The main concerns regard: carbon soil management; nitrogen leaching; erosion control; pest management in crops; the farm aspects related to the application of one or more cross-compliance measures.		IT
IRRI	define the fertilization plan in particular situations (e.g. Nitrate vulnerable Zones)	is free, online; but is very complex and sometime hardly usable	IT

3.3 Barriers and potential for future DST usage

3.3.1 Barriers in dissemination and uptake of DSTs

While prospective barriers regarding DST formats have been outlined in a previous section, a number of additional considerations are relevant within the context of future DST usage and uptake. A broadly expressed concern relates to the issues of dissemination and implementation. Widespread implementation, in particular, could face several obstacles.

The issues of time and *short versus long-term perspectives threaten DST usage* amongst all targeted user groups. Policy makers in particular raised related concerns about these issues, acknowledging their own time constraints and constant need to 'juggle competing priorities'. Farmers' time is also under high demand and their priorities can be different than perhaps expected; a British advisor pointed out that "a farmer will prefer to sow a field of barley than attend a meeting to complete an IACS form which potentially will earn the farm a lot more". This rationale stems both from the issue of limited time, but also exemplifies a common phenomenon of acting with short-term economic gains as one's main driver. "Due to a low level of environmental awareness, farmers will not accept voluntary measures or activities that require immediate expenses, but bring benefits in the long-term. This is reflected in advisory services, as advisors are unwilling to promote such practices" (Polish policy maker). This sentiment was echoed by all respondent countries, stressing that a DST on soil carbon aims to facilitate a long-run effect for which economic benefits may be difficult to exhibit to the farmers.

Scientific ambiguity – while a barrier in and of itself – serves to further compound farmers' unwillingness to invest in long-term efforts. A high degree of uncertainty about carbon at the simplest level as well as a general lack of knowledge about climate change and mitigation practices within all user groups was highlighted by Spanish, Polish and British respondents. This absent scientific consensus leads to a lack of motivation by farmers to change their behaviors without financial incentives/fines. As a Polish interviewee observed, "priority should be given to development of materials presenting relations between agriculture and climate protection and the resulting need for higher carbon sequestration, but it will be difficult to popularise these techniques if farmers do not obtain any financial support for their application".

An additional category of barriers relates to lacking information and skills. On a fundamental level, there is often a lack of information available from farmers to input in the DST (e.g. soil analysis, historical records, etc) and the farmers do not always have this information on hand. For example, a British respondent pointed out that "they don't keep records of fuel use, so they have to estimate these figures", which could lead to less applicable recommendations. Missing detailed and up-to-date data sources covering the large spatial variability of the subject matter was mentioned within the Hungarian context. A lack of education and training of advisors was raised as a further potential barrier, along with missing technical knowledge due to the modern mechanization of practices. Furthermore, it is difficult to develop carbon-related tools without long-term data sets.

Difficulties in providing practical advice given a set of pre-existing constraints also surfaced. The variations between the needs of policy makers, advisors and farmers present a challenge in creating farm or user-specific advice. Furthermore, regardless of the scientific validity of the tools, "farmers act on their gut feelings, not rationally and are not always open to other inputs" (Danish policy maker). Aspects such as tradition and family history on the farm can also serve to prevent farmers from being open to new ideas.

Finally, logistical considerations are a potential barrier. Given that tools and models are all developed separately and are "distinct, with no continuity or integration, a lot comes down

to funding and different organizations skills and methods. People are happy to throw in a chuck of money, but not happy to support the tool after it is developed. That's the continuing problem" (British policy maker). Skepticism about long-term financing for operational tasks and updating duties was also expresses by Hungarian interviewees. This leads to a further question of whether tools should be open access or should be charged for, in order to ensure a more reliable funding source for maintenance and improvements. Charging, however, creates an additional immediate barrier (Hungarian advisor).

3.3.2 Potential for future use

Despite possible barriers, DSTs are seen to be relevant for communicating issues and improving knowledge among stakeholders. In particular, DSTs can help to address the barriers between research and day-to-day farmer practices. This includes a reframing of the issues being addressed in terms which are more relevant and approachable for all target users. As a British respondent suggested, farmers should first think about their soil nutrients before progressing to carbon management. "It is important to get farmers on to this first step of considering their soil health with soil carbon as an add-on rather than asking farmers to consider soil carbon management first". Phrased differently, beginning with a simpler approach will enable farmers to get used to the processes involved, which then opens the door to gradually introducing additional elements as needed.

Creating venues for feedback and enhanced education/skills training were also prioritized by respondents. By encouraging coaching and relationship building exercises, farmers and advisors alike can overcome some of their hesitations in using DSTs. This could additionally take the form of an expert group to share information, a forum for debate (such as www.chil.org, as suggested by a Spanish respondent), or demonstration projects which illustrate the mitigation potential of certain practices. Specialized trainings by advisors could further help in addressing specific hindrances, such as a fear of technology. To aid in establishing productive relationships, a stable network of qualified experts would be useful.

Finally, technological barriers such as a lack of broadband access can be addressed through increased use of iPhone technology. This potential is, however, limited as mobile coverage remains an issue in many rural areas.

3.4 Integration of tools

The presence of integrated decision support tools varies greatly by case study countries, with the UK having the most examples of such tools. These include, for example, Climate Action plan (Denmark), Planet Scotland (about climate change, profitability and diffuse pollution) (UK), Muddy Boots Crop Walker Programme (UK) and Farming for a Better Climate (UK). The final example, Farming for a Better Climate, is "farmer focused and dressed to be about climate change in terms of its title and genesis, but it's sold to the farmer on farm efficiencies, slurry use and targeting with fertilisers to maximise return per unit. It's how it's billed and delivered to get people on board, but this has positive influence for climate change per unit of production and diffuse pollution". Additionally, the Soil Association in the UK has a project on farming efficiencies which draws a link to climate change and diffuse pollution, but also to farm business considerations such as cost effectiveness.

An additional British respondent had a slightly different opinion, stating that within the UK, "there was a programme that was supposed to be a farm account programme that was meant to keep all the farm records, but from what [the respondent] heard, it's rather

cumbersome and doesn't do what it's meant to very well". Efforts are currently being made in Italy within the National Rural Network which aims to integrate all databases provided by AGEA-SIN, AGRIT (statistic program on land use), the National Research Institutes and the Ministry of Environment.

Danish advisors see a huge potential for using DSTs if they are integrated with existing tools (such as Markonline and DLBR[2]). Integration with Planet was recommended by a British policy maker, who further stated that essentially any tools based on nutrients would be useful, because this would be "taking a step in the right direction by looking at their nutrients and it's a case of adding the carbon bit on as a [small] extra". This would encourage farmers to take an interest in their soils and subsequently promote them taking soil samples and go beyond their standard practices.

However, several respondents cited the lack of integrated tools to date. This was the case in Hungary, with the exception of cases supported by similar interest groups (e.g. input supplier), and Italy (although, as previously stated, efforts in this direction are currently underway). In other contexts, such as the UK, individual programs were referred to as tending to work well by themselves, but not as combined programs. In Poland, there is a large variety of available tools which are developed in parallel by different institutions of agricultural support and frequently refer to the same subjects. In this interviewee's opinion, "there is a lack of measures that would allow for better integration of various tools available for advisors and farmers". While several attempts were made for integrating different tools in Hungary, a lack of interest, finances and incentives prevented their success.

Additionally, ideas for where such integration should or could potentially take place were offered by respondents. Suggestions included increasing collaboration between national and European projects and harmonizing activities and tools between research and industry. A Danish respondent also offered the proposal of integrating tools on soil carbon and soil compaction.

3.5 Expectations for a SmartSOIL tool

A range of responses were provided regarding expectations of what the role a SmartSOIL tool could be, and how best to approach its development.

Regarding the role of SmartSOIL, interviewees had several ideas. One proposal was that the tool could provide a forum for technical and social debate on soil management and climate change. It can further create an opportunity to engage with politicians and policy makers regarding the importance of correct soil management, illustrating "what a farmer can practically do under their constraints, the options available and how [farmers] make their decisions" (British policy maker). The tool should also provide a means by which farmers can become aware of available technologies and learn how to best manage their soils. A Danish respondent emphasized the value of the tool in providing an education in carbon dynamics at a field level (e.g. ploughing at different times); they suggested that a net carbon balance calculator based on the soil type, crop and cropping history and inputs applied could be useful to assess the carbon budget at a this level.

Development of a new tool, according to over half of the case studies, should be practically oriented and take into consideration what famers are capable of achieving on their own

[2] Available at http://it.dlbr.dk/DLBR_IT.htm

farms. In other words, a SmartSOIL tool should be used as an add-on to what farmers are already doing and utilize topics and tools with which they are familiar with. In order to increase to increase the tool's applicability across the EU, a range of factors (regional considerations) need to be included. One respondent noted the need for "a holistic approach having add-ons to existing information [and] modules that reflect the carbon agenda and diffuse pollution as well" (British policy maker). Additionally, offering a suite of tools would help to increase uptake as some farmers are very used to only using technology.

3.5.1 Content

In interviews, respondents were also asked to rank a list of possible contents for the SmartSOIL tool. Table 3 shows this list in order of decreasing importance.

Table 3: Ranking of possible content of SmartSOIL tool in order of decreasing importance

Ranking of possible content in order of decreasing importance:
1. Priority list of practices which are most cost effective (highest income relative to costs of practice) for optimal for carbon sequestration
2. Real life case studies of farmers using certain practices
3. Best practice examples for how to promote a certain practice (i.e. good advisory tools or approaches)
4. Priority list of practices which are optimal for carbon sequestration and crop productivity: specific information for regions and country level
5. Priority list of practices in terms of win-wins and trade-offs with other environmental objectives under regional conditions
6. Information to determine at what types of farm to promote a certain type of practice (i.e. at what sectors does it need to be targeted to achieve maximum impact)
7. Information to determine where to promote a certain type of practice (i.e. where it needs to be geographically targeted to achieve maximum impact)
8. Visual presentation of the effects of practices (on carbon storage and other services) in the short and long-term
9. Priority list of practices which are optimal for carbon sequestration: specific information for regions and country level
10. Effect of management practices on carbon sequestration under different climate scenarios

In addition to the ranking, respondents also provided additional insights in relation to the SmartSOIL tool. A strong theme that emerged was the need to frame soil carbon management as an element of sustainable soil management, rather than place too much emphasis on carbon management as such. A British advisor emphasized that: "To get them thinking about carbon management, it should be discussed as part of soil management and overall soil health rather than a specific tool regarding carbon. Farmers need to be encouraged to think initially about their soils as part of a whole farm management plan." A British policy maker expressed the concern even further, stressing the need not to overemphasise climate change: "whatever comes out of this should not be about sustainable farm management aimed at reducing threats to soil under climate change. It should be about good soil management rather than climate change, which is subject to the vagaries of politics and whether or not the farmer believes in climate change. Good soil management is more likely to engage farmers" (British policy maker).

Moreover, the majority of respondents further highlighted the need to address economic factors within the tool, such as productivity and production efficiency (cost savings).

Additional topics which were deemed important by individual respondents include: fertilizers, seed bag, grazing intensity, soil and sward damage, pesticides, and fungicides.
Finally, the importance of linking information to available incentives/subsidies and ecological services considered in future CAP measures was emphasized by majority of respondents. Here, the importance of collecting and fully displaying regulatory considerations was raised by a Hungarian advisor in order to help the farmers decide what rules and regulations they need to meet. This indicates that it will be important to provide some link within the tool with the regulatory requirements and voluntary opportunities that emerge from the reformed CAP regulations to be confirmed in 2013.

3.5.2 Format

Similarly to the views regarding DSTs in general, format preferences for a SmartSOIL tool are also varied. Nonetheless, there was clear agreement among respondents that "one size doesn't fit all" and that a combination of formats will likely be necessary to reach the desired target groups. Accordingly, the format should be determined in relation to specific target groups and the issues at hand. DSTs aimed at farmers should focus on ease of use, while tools directed at advisors can incorporate more complex formats and outputs. The issue of language was also raised, emphasizing the importance of translating the DST into users' native languages in order to ensure clear understanding and utilization (Italian advisor).

Maps were highly prioritized by two thirds of respondents. In Denmark, all interviewees see the use of maps/GIS/GPS as an important player in the future and hold it to be very relevant for DST on soil carbon – both to farmers, advisors and politicians. It could be integrated with existing GPS-based services provided for liming and fertilization. Hungarian respondents mirror this perspective, highlighting the utility of farmers holding onto a physical map while working on their land while being provided with additional short descriptions of what should be done and how. Italian respondents supported these points, also suggesting the value of nationally applicable maps on, e.g. soil erosion. The limitations of mapping, however, were also raised by a British policy maker: "Mapping is very difficult to do. You have to overlap internet GIS mapping with different soil parameters."

The value of information distributed in printed formats was also raised by the majority of countries. Recommendations tables in particular which provide concrete examples (e.g. per farming system type or on the interactions between different parameters, such as productivity, sequestration, adaptation aspects, other ecosystem services, etc) were advocated by Danish and British respondents.

While some interviewees stressed the usefulness of manuals, leaflets and guidelines in and of themselves (e.g. Hungary, Denmark, UK), their utility is more dominantly thought to be improved when combined with additional formats. For example, a Hungarian respondent highlighted that printed material is necessary and is useful to call attention to a topic, "but only short leaflets should be provided based on a mailing list. More detailed material should be available upon request or downloadable. The whole thing should be organized around an internet site, where online/downloadable calculator could be placed as well." Alternatively, printed materials could also be made available on iPhones as an app. A British advisor suggested that "an ideal assemblage would be to also create an electronic version [of printed materials] with a link to a map that was accessible on a smartphone".

Additional policy makers emphasized the need to adapt printed and other materials to local, farm specific factors. An Italian respondent declared handbooks and guidelines 'useless' to

date at the Ministerial level as contextual factors are not yet integrated. Hungarian and British interviewees also underlined the significance of integrating case studies and regional examples to increase the value of materials. “In terms of getting farmers to take up these measures it’s one-to-one advice using a manual for guidance, sitting down and going through the manual” (British policy maker). One proposal for developing a more relevant tool was to create an interactive format to ensure that “the provided information is not generic, but can be personalized by the user. For instance, handbooks are apt for research, not for management and are not effective to spread new practices and enhance awareness” (Italian policy maker).

Regarding computers and the internet, strong feelings against excel programs were expressed. As the program is not known or used by everyone, an excel-based DST would automatically have a restricted user group (Hungarian advisor). This sentiment extended to Denmark, where excel-based calculators were also given the lowest priority of available formats. The internet, on the other hand, was more positively viewed as a flexible, easy to update platform by which programs tailored to individual farms could be downloaded to integrate information collected from the government (British advisor). A Hungarian respondent stated that: “the best format would be a specific webpage, with DST, best practice, actualities, etc. Links to other sources should be also included”. For all of these options, it would be useful for advisors to sit down with farmers and make them aware of how to use computer systems, taking them through the process for their own farm” (British policy maker).

Utilizing a phone-based format was suggested by half of the respondent countries. Smartphone applications were acknowledged as being utilized with increasing frequency, but limited to younger generations and varying by target group. That being said, the potential in using this medium was acknowledged by Hungarian, Danish, British and Polish respondents.

Taking these considerations into account, the need to integrate several formats in a single constellation in order to achieve optimal results becomes clear. The necessity of catering such tools to local contexts also emerged, alongside the desire to complement tools with “practical demonstrations, education and organized open days” (Hungarian policy maker). Best practices and case studies can also be integrated into tools (Spain; UK).

3.5.3 Potential for integration with other tools

SmartSOIL is seen to offer a new and unique opportunity to coordinate and combine the variety of different initiatives that currently exist. As some respondents viewed SmartSOIL as being too specific, an overarching recommendation was to make the tool broader and integrate wider issues, such as fertilisers, grazing intensity, soil and sward damage, pesticides etc. (see section 3.5.1 for more details). A British policy maker also proposed the idea of integrating existing farm accounting tools as several are already looking at GHG; here, CALM was suggested as a possible option if the sequestration element was improved. In addition, further tools which may be relevant as options for integration are listed in Table 4 below.

Table 4: Tools which may be relevant for integration with the SmartSOIL DST

Relevant tool	Additional information
Biodiversity	The Biodiversity Planning Toolkit is a new versatile online resource - aimed at

Relevant tool	Additional information
planning toolkit	helping users to incorporate biodiversity into the planning system and new development. The tool makes use of visual tools as well as text. (http://www.biodiversityplanningtoolkit.com/)
Windfarm carbon calculator	This guidance presents a method to calculate carbon emission savings associated with wind farm developments on Scottish peatlands using a full life cycle analysis approach, via the Excel spreadsheets available from this page. This tool can be used to look at the wider emissions and savings of carbon associated with wind farms (http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Energy-sources/19185/17852-1/CSavings)
Fen management handbook	The Handbook highlights practical techniques but also provides the background science that underpins the different fen management techniques. The handbook is aimed at anyone involved in fen management, creation or restoration from a practical, policy or planning perspective (http://www.snh.gov.uk/about-scotlands-nature/habitats-and-ecosystems/lochs-rivers-and-wetlands/fen/)
Upland management plan manual	An important focus of upland paths work is on safeguarding and enhancing the landscape, and in protecting important habitats - a reflection of the high value we place on our wild places for enjoyment and conservation (http://www.snh.gov.uk/land-and-sea/managing-recreation-and-access/access-and-recreation-policy/paths-policy/upland-paths/)
Strategic locational guidance for windfarm	SNH's vision is that onshore wind farms in Scotland will be sited and designed to minimise adverse impacts on Scotland's natural heritage, and in particular to avoid harm to landscapes and habitats of national or international importance (http://www.snh.gov.uk/policy-and-guidance/policy-documents/document/?category_code=Policy&topic_id=1122)
ICAS database (SG database for applications for SFP)	Offers one to one advice and a scoping visit with farmers and gives general recommendations. They are now offering free soil sampling and testing for organic matter, but that is just taking a photo of what is happening in that year.
Soils4profit	Works with farmers to help them improve their soil, manure and nutrient management whilst also signposting to other sources of relevant support (http://www.naturalengland.org.uk/regions/south_west/ourwork/soilsforprofitproject/default.aspx)
Muddy Boots Software	Muddy Boots is a leading international expert in the provision of traceability and quality assurance solutions for food and farming. Our expertise in grower to retailer solutions has led to the development of a portfolio of software systems that operate at every level in the food supply network (http://en.muddyboots.com/)
FarmPLan Software	Farmplan's software range is designed to help agricultural and rural businesses demonstrate compliance with legislative record keeping and cross compliance requirements as well as monitor and manage business performance. (http://farmplan.co.uk/software.aspx)
DLBR; markonline	Provides the best conditions to quickly adopt the latest agricultural expertise on your farm and the opportunity to optimize production and economy (http://it.dlbr.dk/DLBR_IT.htm)

3.6 Conclusions

This consultation illustrates some important points which need to be considered in the development of the SmartSOIL DST. First, the significant variation in experience with DSTs, current usage levels, preferences with respect to the content, format and relevant features confirms the value of adopting a toolbox approach rather than developing a single overarching SmartSOIL tool. In developing the prototype of SmartSOIL DST the scientific outputs from WP1 – WP3 will need to be matched carefully to the preferences and needs of potential users, and the toolbox approach will increase the likely effectiveness of this

exercise. Second, the SmartSOIL toolbox may be more effective if soil carbon management is framed as an element of sustainable soil management and in terms of production efficiencies (productivity and cost efficiencies), rather than focusing on carbon management and productivity on its own. In particular, it would be beneficial to consider the integration of issues such as fertilizer, nutrient use, grazing intensity, soil compaction, soil and sward damage, and pesticide use. Third, potential for integration with other tools needs to be carefully assessed. Finally, the possible role of SmartSOIL toolbox as an awareness-raising tool and a tool to facilitate societal debate and decision-making beyond farm level needs to be considered when developing both the toolbox and the dissemination activities.

Appendix 1: Guidance for case study partner first consultation and Interview templates

SmartSOIL Decision Support Tool - Questions for first consultation GUIDANCE

Respondents

Carry out interviews with a minimum of 7 people but aim for 10 people. Please try to interview four policy makers (2 in case study area) and four advisors (2 in case study area).

The main people to interview are:
1. Policy makers - these can be at the national or regional level. It may be useful to include mid level policy makers who link with practitioners, for example, those that work in agencies or programmes that implement policy. Their focus would be in the area of soil conservation, diffuse pollution or mitigation of climate change, or as close to this as possible.

2. Advisors – these can be at the national or regional level but must include arable crop advisors as well as those who work in public good initiatives (eg soil protection, diffuse pollution, climate change mitigation programmes).

It is important to identify the most appropriate person to talk to (ie someone who knows about or has experience of DST in relation to cropping, diffuse pollution, or soil management). This may need some research and a few phone calls before you can conduct the interview.

Interview method

The interview can be face to face or by telephone.

Please record the interview (ask permission of the respondent first) and retain the digital files as a record of the interview.

The interview schedule (questions)

There are two interview schedules attached 1. for policy makers and 2. for advisors.

Please try and get your respondents to answer all the questions. If a lot of the questions are not relevant you will need to identify another person to interview. We need to reach seven to ten relevant interviewees.

.

Reporting and Analysis

Transcribe each interview. In English

Use the interview template as the template for transcription.

Prepare a summary analysis (2 pages) for your case study of the main points that have emerged from all your interviews using a template which will be provided.

Deadline 31 May 2012

Suggested email contact template

Dear…

I am writing to consult you about the development of a decision support tool (DST) within the European funded project SmartSOIL (Sustainable farm Management Aimed at Reducing Threats to SOIL under climate change) www.smartsoil.eu

SmartSOIL is concerned with soil carbon management and climate change adaptation in arable and mixed farming systems in Europe. Within this project we are identifying cost effective crop and soil management practices that are optimal both for carbon storage and crop production under changing climate conditions.
SmartSOIL will develop a DST for policy makers and advisors to help them select such practices appropriate to their particular regions and farmers.

As part of the development of the DST we are consulting stakeholders across Europe with a particular focus on six case study regions. [insert your case study area] is one of these case study regions.

Specifically we are asking stakeholders:

- What types of soil management practices are already being promoted and what are the barriers to their uptake?
- What types of decision support tools are in use - what type (manuals, computerised, excel sheets etc) of tools are used, what features work well, what do not work well?
- What are the barriers to the effective use of a decision support tool?
- What type of information can SmartSOIL provide that will be helpful to policy makers and advisors?
- What type of DST can SmartSOIL develop that will be helpful to policy makers and advisors?

I would be grateful if you could spare some time for a face to face or telephone interview which will take about 45 –60 minutes to help with this consultation.
If there is a more appropriate person to talk to in your organisation please pass this email on to them.

Appendix 2: Interview schedules

SmartSOIL Decision Support Tool - Questions for first consultation

INTERVIEW TEMPLATE: Questions for Advisors (focus on arable advisors and advisors for mixed farming systems)

Please read the Background Note on DSTs at the end of this template before starting your interviews.
Please try to obtain as specific information as possible, naming concrete examples and, if possible, providing links.

First ask an open ended question; provide options as prompts if no answer is given

Name:
Position/Organisation:
Name of interviewer:
Date:
Type of interview:

Role of the advisor

Describe the role of the advisor (and the sorts of farmers he/she deals with) to put the interview in context, eg:

- Main role (public or private)
- Main type of production (cropping systems)
- Average farm size and intensity
- Main soil types and soil management problems in the area

Promotion of soil and crop management practices

1. What type of soil/crop management practices do you give advice on? (Soil protection/ diffuse pollution programme, cross compliance, fertilisers?)

2. Do you recommend or advise on practices that specifically promote soil carbon management of soil (soil mitigation and adaptation practices)? Such as:

- Catch and cover crops (n N-fixing and 2nd crops in one year/growing season (prevent bare soil)
- Residue management (keep in field, modify and return)
- Soil management (reduced operations such as tillage, harvest of tuber and root crops)
- Manage Rotations including permanent cropping (rotation with longer/shorter grass)
- Manure and fertiliser management

- Others

And if so in what context? For example, are they part of cross-compliance, or agri-environment measures or part of efforts to increase productivity …?

3. To what extent are farmers/advisors aware of these practices?

4. Are advisors recommending use of these practices ? If not, why not?

5. Are farmers implementing these practices? If not, why not? Are there differences between different types of farms?

6. What could be done to overcome the barriers to the use of these practices?

7. If awareness is a problem with adoption of practices, what information do you think would be useful to raise awareness of these practices?

Use of decision support tools

8. What types of decision support tools do farmers/advisors in your area use?

NB Explain that DST are not just computerized tools they include manuals, tables etc

- Farm records
- Farm accounting
- Recommendation tables …
- Manuals for good farming practices
- Farm carbon calculators …

9. Which of these tools do you have particular experience of?

10. What formats do these tools use? Are these formats effective for providing support? Why yes, or not?
    - Calculators in Excel format
    - Leaflets
    - Written manuals
    - Phone applications – what types?

11. What format do farmers/advisors prefer?

12. What are the useful features of these tools? Please be as specific as possible. For example

    - Type of information that they provide
    - Format in which information is presented
    - Entry of input information
    - Integration with other tools

13. How much do advisors/farmers rely on computers in their decision-making process? Distinguish here between decision making and record keeping

14. What potential do you see for use of computerized decision support tools by farmers / advisors? What type of farmers / advisors might rely on these tools more?

15. What barriers do you see for the use of decision support tools? How can these be overcome?

16. Do you know of examples of integration of decision support tools (for example tools addressing both fertiliser recommendation with diffuse pollution) what experiences have you had with such integration? How are tools integrated?

Or are there examples of tools using a common portal or signposting each other or using farm records as a basic starting point?

SmartSOIL Decision Support Tool(s)	
17.What type of information could SmartSOIL project provide that would be useful for farm advisors and farmers? Please prioritise your choices by assigning values 1, 2 or 3 and explain your answers (1 is the highest priority). *It would be helpful to show respondents his list*	
Priority list of practices which are optimal for carbon sequestration: specific information for regions and country level	
Priority list of practices which are optimal for carbon sequestration and crop productivity: specific information for regions and country level	
Priority list of practices which are most cost effective (highest income relative to costs of practice) for optimal for carbon sequestration	
Priority list of practices in terms of win-wins and trade-offs with other environmental objectives under regional conditions	
Effect of management practices on carbon sequestration under different climate scenarios	
Information to determine where to promote a certain type of practice (i.e. where it needs to be targeted to achieve maximum impact)	
Information to determine at what types of farm to promote a certain type of practice (i.e. which sectors it needs to be targeted at to achieve maximum impact)	
Real life case studies of farmers using certain practices	

Best practice examples for how to promote a certain practice (i.e. good advisory tools or approaches)	
Visual presentation of the effect of practice (on carbon storage and other services) in the short and long-term	
List of relevant regulatory requirements	
List of funding opportunities for measures	

18. In what format should this information be presented:
    a. Manuals with specific guidelines
    b. Recommendation tables (for example, per farming system type, interaction between different parameters – productivity, sequestration, adaptation aspects, other ecosystem services)
    c. Maps
    d. Calculator in Excel format
    e. Smartphone applications

19. With what other tools or information do you think the SmartSOIL tool(s) could be integrated?

Background Note: SmartSOIL Decision Support Toolbox

Decision-support tools (DST) have been increasingly utilized as useful support mechanisms in decision making processes in agriculture. They are usually computer-based tools that help stakeholders balance multiple objectives by enabling them to answer 'what if' questions and see possible outcomes of a range of scenarios. This ultimately provides scientific guidance to farmers for making timely and well justified investment decisions. While the specifics of DST characteristics vary greatly depending on the intended application and user group, they can generally be defined as being interactive, adaptable and flexible computer-based information systems. Environmental models, databases, geographic information system (GIS) and assessment tools are typically integrated in some combination into an easy-to-use interface (Denzer, 2005).

SmartSOIL project aims to develop a decision-support tool. However, SmartSOIL DST will adopt a broader approach. Instead of a single computerized tool, the project will develop a **SmartSOIL Decision-support Toolbox.** The toolbox will integrate multiple tools, drawing on different outputs of the scientific and socio-economic analysis. Individual tools in the toolbox may include, for example, a manual for good farming practices, recommendation tables for selection of priority mitigation/adaptation practices, a carbon/productivity calculator, or visual representations (videos) of the effect of practices at field or regional / national level. The content and format of the toolbox will be determined based on the actual outputs of the project, including the consultation with stakeholders on their needs and preferences in decision-support in relation to soil carbon management and crop management. Through an interactive and reiterative process, the aim is to produce a toolbox that matches the findings of the project to the needs of end users. Moreover, the SmartSOIL toolbox will aim enable the integration of advice across different objectives beyond soil carbon management and productivity concerns (for example, to include other environmental objectives). The target audience for the SmartSOIL toolbox will be EU and national policy makers, and national and regional advisory services.

Below are two examples of the type of tools that could be integrated into SmartSOIL toolbox.

CALM (Carbon Accounting for Land Managers)

The CALM Calculator is a free, business activity based calculator which presents the annual emissions of key greenhouse gases as relates to the activities of land-based businesses. By elucidating the carbon balance of individual businesses, managers can make more informed decisions about how to mitigate climate change via the reduction of GHGs.

The tool was produced in the UK by the Country Land and Business Association in partnership with Savills. The original calculator was created with support from the East of England Development Agency and the Crown Estates, and has been upgraded with financing from Natural England.

More specifically, the CALM tool balances *carbon dioxide, methane and nitrous oxide emissions* against *carbon sequestered in soils and trees*. The measured emissions are those originating from:

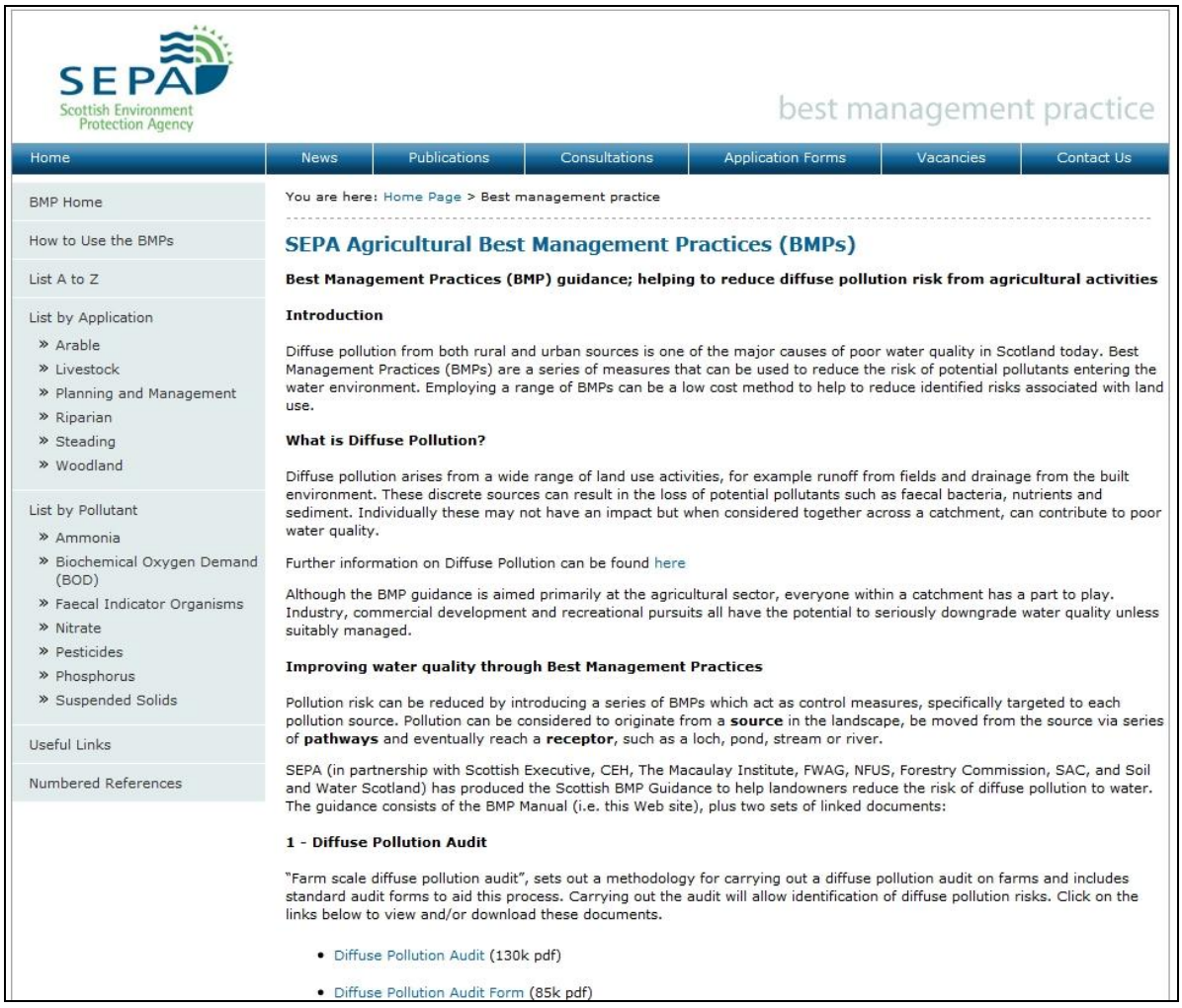
1. Energy and fuel use,
2. Livestock,
3. Cultivation and land-use change, and
4. The application of nitrogen fertilizers and lime.

The calculator additionally serves to assess the economic impact of joining or maintaining participation in Environmental Stewardship schemes. Instead of carbon capture (sequestration) being directly measured, annual changes in emissions pre and post entry are focused on.

Logistically, the tool functions via a series of data collection and entry steps which ultimately produce an output report. Data inputs are divided into two main areas – emissions and sequestration – and are further categorized into 'fields'. Physical data for crops, stock and energy use are required. Once this data has been entered, an output is produced which can be formatted as desired. Finally, the advisory notes on mitigation provided on the tool website can be consulted in order to assess ways in which one's carbon balance can best be improved. Information on potential economic savings to be attained from specific mitigation actions (e.g. based on efficiencies of inputs) is also available.

Source: http://www.calm.cla.org.uk/

SEPA Diffuse pollution manual: http://apps.sepa.org.uk/bmp/



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Scottish Environment Protection Agency

best management practice

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SEPA Agricultural Best Management Practices (BMPs)

Best Management Practices (BMP) guidance; helping to reduce diffuse pollution risk from agricultural activities

Introduction

Diffuse pollution from both rural and urban sources is one of the major causes of poor water quality in Scotland today. Best Management Practices (BMPs) are a series of measures that can be used to reduce the risk of potential pollutants entering the water environment. Employing a range of BMPs can be a low cost method to help to reduce identified risks associated with land use.

What is Diffuse Pollution?

Diffuse pollution arises from a wide range of land use activities, for example runoff from fields and drainage from the built environment. These discrete sources can result in the loss of potential pollutants such as faecal bacteria, nutrients and sediment. Individually these may not have an impact but when considered together across a catchment, can contribute to poor water quality.

Further information on Diffuse Pollution can be found here

Although the BMP guidance is aimed primarily at the agricultural sector, everyone within a catchment has a part to play. Industry, commercial development and recreational pursuits all have the potential to seriously downgrade water quality unless suitably managed.

Improving water quality through Best Management Practices

Pollution risk can be reduced by introducing a series of BMPs which act as control measures, specifically targeted to each pollution source. Pollution can be considered to originate from a **source** in the landscape, be moved from the source via series of **pathways** and eventually reach a **receptor**, such as a loch, pond, stream or river.

SEPA (in partnership with Scottish Executive, CEH, The Macaulay Institute, FWAG, NFUS, Forestry Commission, SAC, and Soil and Water Scotland) has produced the Scottish BMP Guidance to help landowners reduce the risk of diffuse pollution to water. The guidance consists of the BMP Manual (i.e. this Web site), plus two sets of linked documents:

1 - Diffuse Pollution Audit

"Farm scale diffuse pollution audit", sets out a methodology for carrying out a diffuse pollution audit on farms and includes standard audit forms to aid this process. Carrying out the audit will allow identification of diffuse pollution risks. Click on the links below to view and/or download these documents.

- Diffuse Pollution Audit (130k pdf)
- Diffuse Pollution Audit Form (85k pdf)

SmartSOIL Decision Support Tool - Questions for first consultation

INTERVIEW TEMPLATE: Questions for (mid level practitioners) policy-makers (national / regional)

Please read the Background Note on DSTs at the end of this template before starting your interviews.
Please try to obtain as specific information as possible, naming concrete examples and, if possible, providing links.

First ask an open ended question; provide options as prompts if no answer is given

Name:
Organisation:
Interviewer:
Date:
Type of interview:

Role of respondent for context
Describe the role of the respondent for context, eg area of policy interest, position within their organisation, key experiences

Promotion of soil and crop management practices
17. What type of soil/crop management practices do you promote as part of a soil protection/ diffuse pollution programme? 18. Do you promote practices that specifically favour soil carbon management of soil (soil mitigation and adaptation practices)? Such as: • Catch and cover crops (n N-fixing and 2nd crops in one year/growing season (prevent bare soil) • Residue management (keep in field, modify and return) • Soil management (reduced operations such as tillage, harvest of tuber and root crops) • Manage Rotations including permanent cropping (rotation with longer/shorter grass) • Manure and fertiliser management 19. How do you promote soil protection practices (including those in Q2)? • Voluntary awareness raising? How? • Regulation? Cross compliance? • Policy incentives? 20. What types of information do you use to promote awareness of these practices and soil conservation in general?

- Leaflets
- Codes of practice

21. To what extent are advisors and farmers aware of these practices and to what extent do they implement them? What are the barriers/incentives to their uptake?

Design of soil protection measures
22. What information was used to design soil protection measures and practices and in what format is this information available? o Soil risk maps o Soil quality maps o Water quality (soil sediments) maps o Photographic evidence o Scientific reports (eg, long term monitoring on selected sites) o Manuals or guidance from the European Commission Are there any particular gaps in information?
Use of decision support tools
23. What decision support tools have you used or know of (please name the tool(s)): *NB Explain that DST are not just computerized tools they include manuals, tables etc* • Please provide some background: when, who, for what purpose, was the tool designed for? • How was it developed? What and who was the key driver in its development? (regulation, food assurance, industry etc..) 24. What format do these tools use?: o Manuals with specific guidelines o Recommendation tables (for example, per farming system type, interaction between different parameters – productivity, sequestration, adaptation aspects, other ecosystem services) o Maps o Calculators in Excel format o Smartphone applications o Databases o Other software: o … 25. What issues do the tools address? o Carbon soil management o Nitrogen leaching

- Erosion control
- Pest management in crops
- Optimized nutrient management for crops
- Optimized irrigation scheduling

26. Can you describe the tool, how it functions, what you found was useful and not?
    - Type of information provided
    - Type of farming system targeted
    - Useful elements
    - ….

27. What barriers do you see for the use of decision support tools? How could these barriers be overcome?

Ask about sustainability of tool. Has the tool continued to be funded and supported after its development?

28. Do you know of efforts to integrate different tools and provision of advice to farmers? If yes, can you explain in more detail what this integration entails

29. Could you suggest contacts that could provide more information on the tool(s)?

SmartSOIL Decision Support Tool(s)	
14. What information could SmartSOIL project provide that would be useful for policy making and awareness raising (EU / national level)? Please prioritise your choices by assigning a value 1, 2 or 3 and explain your answers…. (1 is the highest priority) It would be helpful to show respondents his list	
Priority list of practices which are optimal for carbon sequestration: specific information for regions and country level	
Effect of management practices on carbon sequestration under different climate scenarios	
Priority list of practices which are optimal for carbon sequestration and crop productivity: specific information for regions and country level	
Priority list of practices in terms of win-wins and trade-offs with other environmental objectives under regional conditions	
Priority list of practices which are most cost effective (highest income relative to costs of practice) for optimal for carbon sequestration	

Information to determine <u>where</u> to promote a certain type of practice (i.e. where it needs to be geographically targeted to achieve maximum impact)[3]	
Information to determine at <u>what types of farm</u> to promote a certain type of practice (i.e. at what sectors does it need to be targeted to achieve maximum impact)	
Real life case studies of farmers using certain practices	
Best practice examples for how to promote a certain practice (i.e. good advisory tools or approaches)	
Visual presentation of the effects of practices (on carbon storage and other services) in the short and long-term	

15. In what format should this information be presented:

f. Manuals with specific guidelines
g. Recommendation tables (for example, per farming system type, interaction between different parameters – productivity, sequestration, adaptation aspects, other ecosystem services)
h. Maps
i. Calculator in Excel format
j. Phone applications
k. A combination of the above

16. With what other tools or information do you think the SmartSOIL tool(s) could be integrated?

[3] For this and the next Q are subtly different for policy makers and advisors. Policy makers are interested in the bigger picture, ie where geographically and at what sectors should they target their efforts. Advisors will probably be interested more in what type of farmer will respond/benefit most