SoilCare
SOILCARE FOR PROFITABLE AND SUSTAINABLE CROP PRODUCTION IN EUROPE

Report describing final stakeholder workshops held in study sites, detailing stakeholder feedback on preliminary findings

Authors: Regina Hansda, Francisco Areal, Mark Reed & Study Site partners

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EU project representative & coordinator of the project:	Dr. Rudi Hessel - (rudi.hessel@wur.nl) +31 317 486 530
Project manager(s):	Erik van den Elsen (erik.vandenelsen@wur.nl), Simone Verzandvoort (simone.verzandvoort@wur.nl), Falentijn Assinck (falentijn.assinck@wur.nl)
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Principle Author(s):	Regina Hansda, Francisco Areal, Mark Reed & Study Site partners
Principle Author e-mail:	regina.hansda@newcastle.ak.uk
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No.	Participant organisation name	Abbreviation	Country
1	Wageningen Environmental Research	WEnR	Netherlands
2	University of Newcastle upon Tyne	UNEW	United Kingdom
3	Katholieke Universiteit Leuven	KUL	Belgium
4	University of Gloucestershire	UoG	United Kingdom
5	University Hohenheim	UH	Germany
6	Research Institute for Knowledge Systems	RIKS	Netherlands
7	Technical University of Crete	TUC	Greece
8	Joint Research Centre	JRC	Italy
9	University of Bern	UNIBE	Switzerland
10	Milieu LTD	MLTD	Belgium
11	Norwegian Institute of Bioeconomy Research	NIBIO	Norway
12	Bodemkundige Dienst van België	BDB	Belgium
13	Aarhus University	AU	Denmark
14	Game & Wildlife Conservation Trust	GWCT	United Kingdom
15	Teagasc	TEAGASC	Ireland
16	Soil Cares Research	SCR	Netherlands
17	Instituto Politecnico De Coimbra	IPC/ESAC	Spain
18	National Research and Development Institute for Soil Science, Agrochemistry and Environmental Protection	ICPA	Romania
19	University of Padova	UNIPD	Italy
20	Institute of Agrophysics of the Polish Academy of	IAPAN	Poland
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25	Crop Research Institute	VURV	Czech Republic
26	University of Almeria	UAL	Spain
27	Fédération Régionale des Agrobiologistes de Bretagne	FRAB	France
28	Scienceview Media BV	SVM	Netherlands
29	Milieu Consulting SPRL	Milieu	Belgium

Report describing final stakeholder workshops held in study sites, detailing stakeholder feedback on preliminary findings

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Authors

Regina Hansda, Francisco Areal, Mark Reed & Study Site partners

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SoilCare
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Acronyms

AMF	Arbuscular mycorrhizal fungi
AES	Agri-environment schemes
GWCT	Game and Wildlife Conservation Trust
LCC	Leguminous cover crops
NFU	National Farmers Union
SOM	Soil organic matter
SDG	Sustainable development goals
SICS	Soil improving cropping systems
UK	United Kingdom

Executive Summary

As part of the Work Package 3, all study site partner institutions of the SoilCare project had to organise a final Stakeholder workshop that brought together a diverse range of stakeholders. This workshop was built upon the ongoing conversations and learnings on soil improving cropping systems (SICS) that have occurred during the entire course of the SoilCare project. The main aim of the workshop, organised mostly in the month of February 2021, was to present the study site experiments to the stakeholders and initiate discussions on the findings. From 2016 onwards, each participant country had the task to identify the specific soil related issues of their study site, the potential soil improving techniques that could help address that problem, and to implement and test these techniques in the field. Through a participatory process the experimental sites were identified, and experiments carried out along with a control. Proper monitoring and evaluation along with recorded maintenance of different inputs and outcomes was done for each of these sites.

Due to Covid-19 restrictions in place, the final stakeholder workshop for most of the SoilCare partnering countries were organised online. There was a wide degree of participation across the different study sites with participation ranging between 10 and 50 participants. There was a broad representation of participation both gender and category-wise. Barring Norway and Belgium, the gender representation in the workshop were slightly skewed in favour of men. In terms of stakeholder-wise representation, the workshops were comprised of farmers, students, researchers, extension service workers, agricultural administration, agricultural scientists, environmentalists and policy makers, but in most cases the largest stakeholder groups that took part were by farmers, followed by researchers. *The broader findings from the workshop are as follows:*

- The SoilCare results were mostly in line with what was anticipated by most stakeholders, but some sites reported more positive results than they expected
- There were concerns around extrapolation of findings given the limited sample size and short duration of the project. There were suggestions for undertaking long-term studies
- For future impacts, potential farmers need incentivisation for both ‘demonstration effect’ as well and for up-scaling of SICS

Introduction

Under the current global challenges scenario, a healthy, fertile soil is at the heart of food security (SDG Goal 2). However, intensive agriculture in Europe (and elsewhere) has, over the last decades increased crop yields, but has also posed severe environmental problems. Building up, maintaining, and conserving the fertility of different soil types around the world, including in Europe, in the face of changing and often adverse climatic conditions is one of the biggest challenges to agriculture today. Different soil studies argue that it is critical that, apart from the production function, various other functions of the soil (infiltration, microbial activity, carbon sequestration) are protected and enhanced because of their socio-economic as well as environmental importance (Jones et.al 2012).

The five-year, multi-sited, multi-country, SoilCare project (2016-2021) was conceived, designed and implemented with the main objective(s) of contributing to the conservation and improvement of soil quality of the farming ecosystems in Europe, whilst also ensuring its long-term profitability. Across the five-year period and across 16 partnering countries, a wide range of consultation meetings on soil fertility related issues were held, potential measures identified, planned, test-implemented and monitored. Part of this initiative also included identifying country-specific soil threats with potential solutions towards the same. Each of the project partners based on their assessment and local consultation with different stakeholders initiated site-specific experiments using different soil improving cropping systems (SICS). Most of these experiments ranged between three to four years.

A Final Stakeholder Workshop was organised by each of the partnering countries and institutions during the month of February-March 2021 involving participants who were actively involved in the project, as well as to the key members of the public and institutions with interest and stake in soil quality and productivity issues. The main purpose of the workshop was to present the findings of the SICS that were experimented upon in each site to the relevant stakeholders, and elicit their feedback and suggestions. The workshop was structured in the following format and it was both *reflective* and *deliberative* in nature. The *reflective* component involved checking with individual participants whether the findings were in line with their own expectations from the project; and

also what was the specific learning and take-away message from the SoilCare project for their own work. The *deliberative* component involved participants collectively reflecting and discussing the existing and potential future impacts from the SoilCare project and the necessary policy measures that could enable a transition to a more healthy and resilient soil system.

The objectives of the workshop were as follows:

- To present and discuss the key findings obtained for the respective site experiments with various SICS with the stakeholders that can play a critical role in address the soil health issue.
- To identify the possible benefits that the experience of participating in the project has had for the participants themselves personally
- To identify and propose different options for the dissemination of the project results that could contribute in increasing the adoption of SICS across the regions.
- To identity what policy measures could support in using or implementing some or all of the project/research findings?

The Final Stakeholder Workshop Report (Deliverable 3.4) is organised as follows. First, after the introduction, which provides the background of the project, it goes on to describe the methods that were used during the workshop in section 2. In section 3, the results of the findings country-wise and its existing and future impacts are presented. Section 4 summarises the policy recommendations and ways in which the experiences from the SICS site experiment can benefit the larger society and public at the large[1]. This is followed by conclusions. Finally, workshop reports for the individual study sites are provided in the Appendices.

[1] The Work Package (WP7) used these findings to draft country reports. D7.2 in particular presented the main policy recommendations; and these reports are downloadable from the following link: https://tinyurl.com/SoilCare-WP7

Methodology

Covid-19 restrictions made it difficult for different stakeholders to travel and assemble in one place, the workshop in each of the project sites, therefore, was mostly (except Hungary[2]) held online. The workshop facilitation was done by the SoilCare study site partner institutes with active participation and support of the participating stakeholders. Different regions organised the meeting in different formats based on the capacities and preference of the participants using Zoom, MS Teams or Google Meet. Most of the workshops began with a PowerPoint presentation which provided an overview of the SoilCare project and the objectives of the workshop. Then the concerned team member (s) were invited to present the findings from the site-specific SICS experiments. The present status of crops on the different experimental plots were also observed and visually assessed. Soil profile and soil characteristics were also studied in the site to provide better and more complex understanding of the results and processes in the soil-plant-atmosphere system.

During the presentation and afterwards, people had the chance to ask questions and/or to give comments and feedbacks in the chat. For the deliberative sessions on existing and potential future impacts from the SoilCare project and the necessary policy measures that could enable a transition to a more healthy and resilient soil systems, different types and forms of technologies (e.g. online post-its) were used to make the workshop as interactive as possible. Additionally, and as a substitute to the post-it exercise, some project sites also offered the participants the option to use the online dashboards (Miro) and survey platforms (*retro.io)* to respond to the questionnaire designed for the workshop. The digital tool helped participants to share their opinion or vote online. Usage of these different digital tools had its own share of methodological challenges, both for the facilitators and the participants. Not all participants were familiar with the use of these different digital tools, so study site partners had to provide extra guidance during the course of the workshop. There were a few participants in some sites who were uncomfortable with audio/video recording, so that the workshop deliberations could not be recorded for future

[2] Hungary organised the workshop outdoor using Covid 19 protocols. Since the workshop was organised in the pre-peak period of Covid-19 restrictions in February, the attendance was substantive with 38 persons attending the workshop.

reference purpose. There were others, who when asked to identify themselves with initials or names when commenting on the Miro board, preferred to register their comments anonymously. From the workshop facilitators' side, there were comments about challenges in holding different exercise sessions which required active participation by all participants. Poland had an interesting experience. Since the zoom link of the workshop was shared on the Institute's website, a hacker interrupted their workshop presentation. The conference organiser had to close the workshop, and re-run it again with few select people. So, a diverse range of experiences for all concerned. But in general, it was a steep learning curve for most. Despite limitations, there was reasonable level of engagement and discussions in most sites.

During the entire workshop, care was taken to note down as much as possible as to who said what, their gender, the role and affiliations with different organisations and with an indication whether there was consensus or disagreement between different stakeholders. Adherence on this aspect of the workshop reporting varied, but it still was useful to get an insight, even if it was from few of the sites.

Discussion and feedback on the findings

Most countries elicited feedback on the findings of the site experiments based on online presentations and discussions (See Appendix 4). However, countries such as Sweden followed a blended approached where they sent questionnaires along with factsheets from site experiments in advance to potential stakeholders. The questionnaire and the factsheet provided scope to all those stakeholders who could not attend the workshop to register their response. It was also helpful for the workshop organisers to have additional insights to plan their discussion points during the workshop.

Based on the online presentations and discussions afterwards in each site, including the analysis of the site experiments, the key soil threats and the broad findings are as follows:

Key soil threats and potential SICS experimented across sites

At the start of the project 11 soil threats were identified across the project sites through a series of consultative process led by WP2[3]. All these threats in a way affect the overall EU soil quality. Different sites had different issues; often a combination of one, two or more than two soil threats (see table 1). Against these soil threats different SICS were experimented in different sites. These experimented SICS in different sites broadly fall within the following soil threats: soil erosion, decline in soil organic matter (SOM), soil compaction, weeds issue and also issues around soil acidity (see figure 1).

Out of the different soil threats, the ones which had maximum occurrences across the project sites were decline in soil organic matter (36%), soil compaction issues (36%) and soil erosion issues (16%) (See figure 1). These were not mutually exclusive problems, rather inter-related. For instance, soil erosion by water also affected the overall organic matter in the soil.

[3] For more details on this, please refer to the WP2 report entitled " A review of soil- improving cropping systems" at the following link https://tinyurl.com/SoilCare-WP2 (see page 11)

Figure 2: Country-wise breakdown of reported soil threats

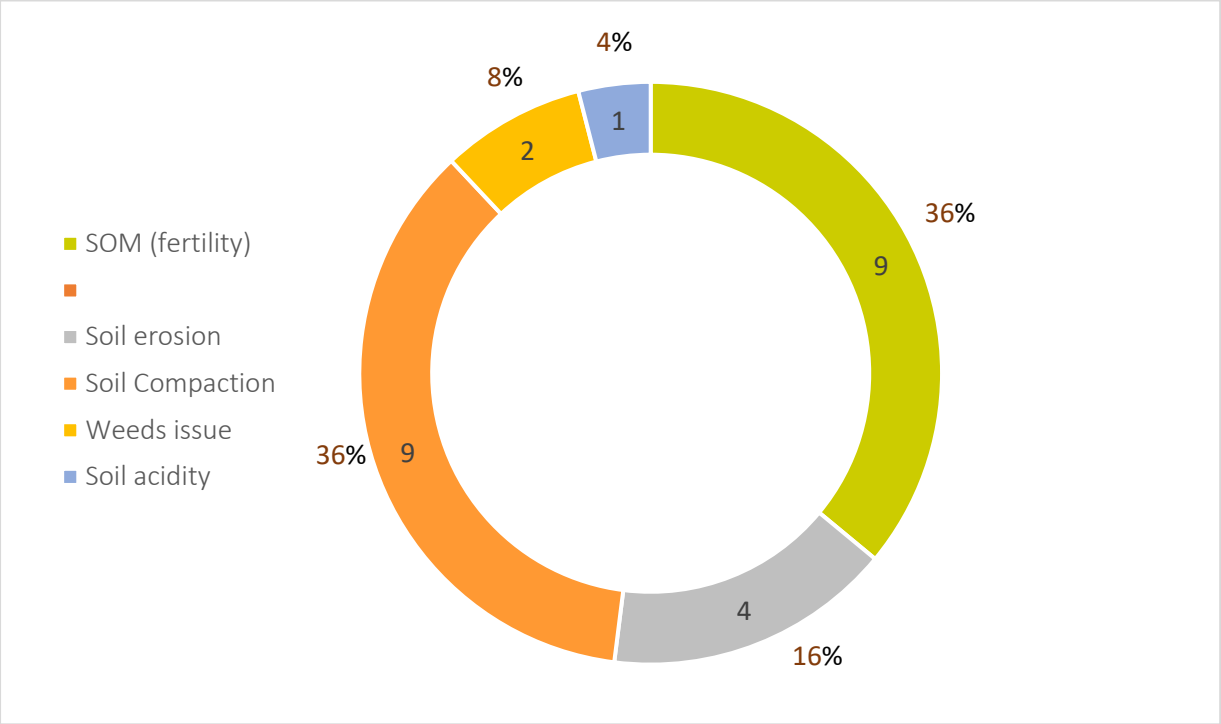
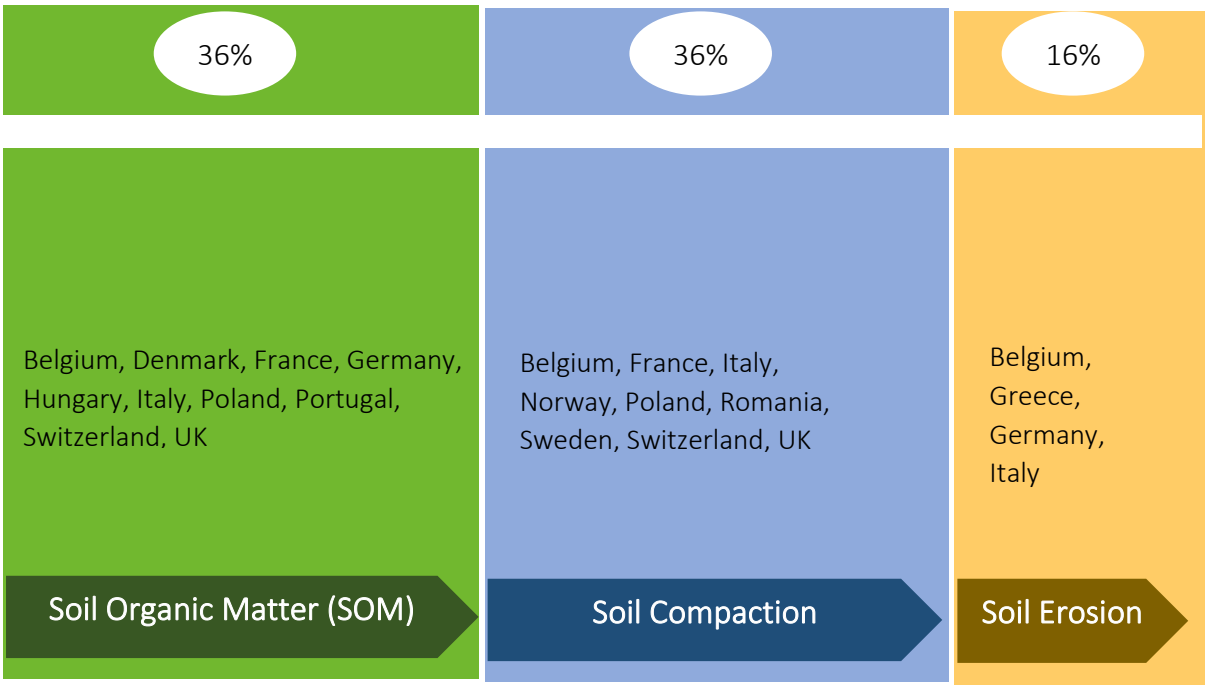


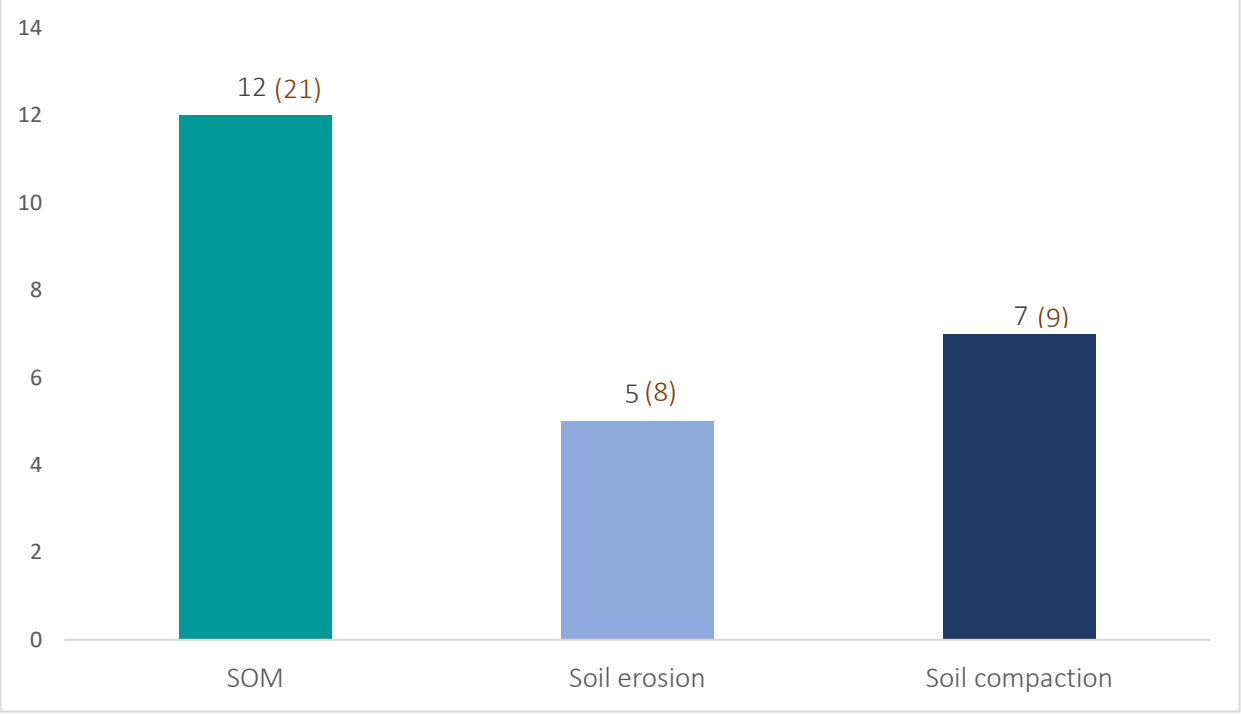
Figure 1: Broad overview of the most important soil threats/soil issues across the project sites



Belgium and Italy for instance, had all the three key soil threats, whereas Greece and Hungary were predominantly concerned with one of the threats, namely soil erosion and decline in Soil Organic Matter respectively. Poland and the UK were concerned with two of the key soil threats, namely soil organic matter decline and soil compaction.

There was a range of SICS that were experimented upon to address the three different soil threats. Across the project sites there were variations in terms of the measures adopted to address the same soil threats. To address the issue of soil organic matter loss (SOM), there were in total 12 different measures (Figure 3) experimented across the different project sites (Table 1). These ranged from experimenting with manure, compost, wood chips, catch crops, cover crops, crop rotation, sub-soiling with arbuscular mycorrhizal fungi (AMF) inoculation amongst others. But the most common SICS measure to address concerns around soil organic matter decline across project sites was *crop rotation* and it was adopted by four countries (Hungary, Germany, Norway and Poland).

Figure 3: Different SICS experimented for each of key soil threats



*Figures in bracket suggest the total number SICs implemented across project sites for each of the soil threats

At times, a single country (e.g. Belgium) has experimented with many different measures that are aimed at enhancing soil organic matter (e.g. compost, wood chips, manure) Similarly, to address concerns around soil erosion there were five options (e.g. Conservation tillage, cover crops) were adopted nine times across different countries. Same with the Soil compaction issue (Table 1).

Broad summary of discussions and feedback

There were wide range of discussions and feedback. For most, the research findings from the experimental sites were plausible and in line with what they had anticipated. Farmers, researchers and technicians in Italy for instance, found the results positive and encouraging in general. However, the farmers here also reiterated that they were expecting a better performance of using tillage radish as cover crops, which was not the case from the current findings. Similarly, Germany reiterated that for farmers, earthworms and other soil organisms do not necessarily play an important role in the decision-making process. The main reason to plant cover crops, one of the top choices (after crop rotation and manure) for enhancing SOM across project sites is to cope with erosion. Further, Belgium found 'wood chips' use as really effective in enhancing soil carbon content and infiltration rate, but they were also concerned about the limited availability of wood chips in the region. In addition, there were concerns across few countries (e.g. Sweden) that one could not see much differences in crop yields in some of the experimental sites, but there were also discussions around the fact how some of the sites were difficult sites, so it is not surprising that the results are not as expected. Farmers in Germany apart from discussing the site findings, also raised issues with the booklet entitled "10 common mistakes and their harmful impacts on soil[4]" that was shared as part of SoilCare dissemination material to farmers. They were of the opinion the booklet consisted of very basic information, and some of the farmers were far ahead in their sustainable agricultural practices. According to them, it would be appropriate to mention the target audience for that booklet, lest it might create misunderstandings and bring bad reputation to experienced farmers. One participant commented "*The level of farmers that is assumed is frighteningly low. Target group must be clearly named to prevent misunderstandings among the general public*. Another point raised about the booklet by different stakeholder categories that it may not be suitable for extension services in Germany, as their "working mode"

[4] The book can be access through the following link https://tinyurl.com/SoilCare-Booklet10mistakes

in communication is different. Some of the comments and discussion points were around approach and attitude towards farmers and that instead of pointing at mistakes of farmers with respect to their soil management practices; it would be worthwhile to demonstrate through positive and proactive conversation as to what benefits do farmers get from a healthy soil. It is also important to point out that the highly technical nature of the discussions prevented some participants (especially policy makers and boundary organisations[5]) from fully engaging in certain segments of the workshop. For instance, the NFU representative in the UK had this to say with regard the site experiments related fact sheet *"…For farmers, is the language right? The information is useful but had to be read through several times to get the key points…"*

The table 1 below presents the list of partnering countries that conducted the site specific experiments related to the different soil threats, the main SICS that were adopted across the project sites, and the wide range of discussions and feedbacks to some of the findings. Apart from the similarities in soil threats and measures undertaken to address some of those concerns, there were sites which stood out for experimenting some uncommon measures for similar problems, and others with distinctive issues which suggest the specificity of the problem and the preferences of remedial measures based on resource and skill availability. For instance, apart from Belgium no other site considered 'wood chips' as an option to address concerns around soil organic matter decline. Similarly, soil acidity issues were reported only from Hungary. Therefore, liming was used as a potential solution to balance out the pH level of the soil.

[5] A formal body jointly generated by the scientific and political communities to coordinate different purposes and promote consistent boundaries and mutually incomprehensible interactions. In the context of agriculture, organisations that sit in between policy makers and farmers and mediate in the interest of farmers (e.g. National Farmers Union in the case of UK and certain Research Institutes that create evidence through their research for effective policy making)

Table 1: Country-wise soil threats, experimental sites, potential SICS[6] as solution and discussion

S. No.	Country *(Experimental sites)*	Soil threats	Main SICS adopted as a solution	Discussion and feedback
1.	**Belgium** *(Flanders)*	1. SOM issues 2. Soil Erosion 3. Soil compaction	1. Manure, compost and wood chips 2. Grass under-sowing (maize) 3. Non-inversion tillage, Strip tillage (dead &living grass)	Interest in woodchips as it is useful from both nitrate and carbon point of view (farmer); interested to know from other SoilCare partners (e.g. Spain); Partnerships between farmers and the cooperative purchase of machines could remove the bottleneck of availability of materials and workload (advisor)
2.	**Denmark** *(Askov, Ribe)*	1. SOM (carbon storage)	1. Catch crops 2. Compost	Data not available
3.	**France** *(Brittany)*	1. SOM issues 2. Soil compaction 3. Weeds	1. Use of different cover crops 2. Reduced tillage through different sowing practices 3. Cover crops & reduced tillage	There were too many soil parameters for each of the cover crops interventions. It would be preferable to target two or three soil parameters depending on each trial objectives. Maize direct sowing failed due to heavy rains, too many weeds around Fabia beans. The general opinion was the success of this practice seemed uncertain in Brittany region.
4.	**Germany** *(Tachenhausen)*	1. Soil fertility issue / Glyphosate use 2. Soil erosion	1. Shallow tillage & crop rotation 2. Cover crops & perennial grasses	Cover crops have the potential to supress weeds. But in this experiment, weed infestation after cover crops was higher than without cover crops. The experiment itself was not designed as to see how earthworms react to intensified tillage. Conclusions too broad for wider relevance and applicability.

[6] For more details, also check SICS reports from D 5.3 (https://tinyurl.com/SoilCare-WP5) and D7.2 (https://tinyurl.com/SoilCare-WP7)

S. No.	Country *(Experimental sites)*	Soil threats	Main SICS adopted as a solution	Discussion and feedback
5.	**Greece** *(Chania, Crete)*	1. Soil Erosion	1. Cover crops (Vineyards) 2. Minimum to no tillage practice (Olive orchards) 3. Crop change (Avocado instead of orange)	The *Olive farmers* wanted some clarifications regarding tillage avoidance especially in dry season, as well as tillage effects on water holding capacity. The *Vineyard farmers* especially wanted to be informed about the way bulk density is measured, the range of its values that is considered sufficient, the depths at which the research team got the samples, as well as the way that the earthworm experiment was applied. They were also interested to learn the measured soil organic carbon rate at both examined plots (vetch or no vetch cover). The *Orange cultivators* raised also some interesting questions concerning the project findings. They focused on the fewer measured earthworms in the avocado's plot and they wondered whether avocados were actually reducing biodiversity. They also wondered whether the reduction in soil erosion in avocado trees was due to the particular slope of the studied plot, and whether in fields with higher slopes this reduce may not be so noticeable.
6.	**Hungary** *(Keszthely)*	1. SOM 2. Soil compaction 3. Soil erosion	1. Crop rotations with minimum & Reduced tillage 2. Straw, instead of FYM	Some of the stakeholders were sceptical about the effectiveness of the microbiological product, since their effect depended on several other biotic and abiotic environmental factors. It was agreed the first step to improve soil microbiological status would be to promote favourable soil properties for biological activity, otherwise neither native nor external microorganisms can work intensively.
7.	**Italy** *(Legnaro)*	1. Erosion (Loss of SOM) 2. Soil compaction	1. Cover crops 2. Conservation tillage, deep rooting tillage radish	Most participants found project results in line with their expectations. However, the farmers expected better performances linked to the use of tillage radish as cover crop. For researchers and

S. No.	Country *(Experimental sites)*	Soil threats	Main SICS adopted as a solution	Discussion and feedback
				students weed infestation under no-tillage management and cover crop phenology seemed the most interesting results, as that could help in making clear protocol on how to deal with conservation agriculture. Moreover, they thought it would be worthwhile to study the effects of SICS on water cycle. Policy makers found the meeting useful to increase their technical knowledge in this field, to be more effective and efficient in the law-making process and in the public relations.
8.	**Norway** *(Øsaker & Solør)*	1. SOM 2. Soil compaction	1. Crop rotation 2. Cover crops (alfalfa grass)	Discussions on experimental design; acknowledgement about lack of experience and how the difference in results were because the field trial sowing was by hand, and how in the farmers field sowing was more precise through centrifugal spreader and therefore better production; discussion on timing of sowing. What was surprising to many was that crop rotations did not show much positive effects on soil organic matter levels. Consensus on the need for longer term research and experimentation on this issue.
9.	**Poland** *(Szaniawy)*	1. SOM &water holding capacity 2. Soil acidity	1. Intercropping, crop rotation & manure (oat, spring wheat & manure) 1) Liming	The highest cereal yield and plant height were recorded in plots with application of manure or liming/cover crops/manure together and the lowest in control plots.
10.	**Portugal** *(Caldeirao)*	1. SOM 2. Weeds issue	1. i) Organic amendment with urban sludge; ii) Legumes as cover crops	After 3 consecutive years of urban sludge application in the agricultural field, the soil fertility increased significantly, almost all the parameters analyses in this study show a positive impact. Overall, combination of soil-improving practices compared to single practice caused the higher increase in crop yields and dry gluten

S. No.	Country *(Experimental sites)*	Soil threats	Main SICS adopted as a solution	Discussion and feedback
			2. i) Organic rice production with Lucerne; ii) manual weed control	content. The other observation was irrespective of soil-improving practice, the crop yields were lower by more than 50% in dry than moist years.
11.	**Romania** *(Draganesti-Vlasca)*	1. Subsoil compaction	1. Tillage - mouldboard ploughing with furrow inversion, subsoiling, disking & chiselling 2. Crop rotations	In order to mitigate the natural subsoil compaction farmers preferred to use a combination of two out of the three SICS treatments which were tested, namely the application of the mould-board ploughing annually and of the subsoiling periodically every 3 years
12.	**Spain** *(Almeria)*	1. Soil crusting (Olive orchards) 2. Excessive water consumption	1. Cover crops with adventitious root grass or planted crops 2. Establishing water efficient irrigation system	Establishing cover crops is highly dependent on presence of rainfall Different permutation and combinations to establish water efficient irrigation system revealed manual water cuts to certain rows, then reducing the pressure in drippers worked well. Positive results on cost savings, reduction in water consumption, enhancement in crop yield and quality.
13.	**Sweden** *Orup* *(Skåne county)*	1. Soil compaction 2.	1. Mechanical subsoil loosening at different depths (35/25cm), use of organic materials and straw pellets	Did not observe any significantly higher yields during the site experiment. Participants seemed to be recognizing that this type of SICS may eventually take several years before the beneficial effects shows up. For using straw pellets, the economics angle needed more clarity
14.	Switzerland *(Thurgau)*	1. Soil compaction 2. SOM 3.	1. Green verges 2. Cultan 3. Green manuring	Out of the three SICS, Cultan technology seemed to be the most impressive in terms of results, followed by Green manuring; and there was consensus in promotion of these two SICS on a larger scale

S. No.	Country *(Experimental sites)*	Soil threats	Main SICS adopted as a solution	Discussion and feedback
15.	UK *(East England)*	1. Soil compaction and flood risk 2. SOM	1. Deep rooting grasses 2. Sub-soiling with AMF inoculation	Most participants didn't find the experiments and the results quite convincing. In comparison with rye glass clover mix, there was not much change in water infiltration and soil compaction between the two; Participants were of the opinion that using Fojtan could contribute to flood risk management if combined with low intensity harvesting. Most participants expressed the need for long-term trials before any conclusive conclusions can be drawn

With regards to the factsheets, for many participants in some countries it was not clear as to who should be the target group of the fact sheets. The opinion of some extension service representatives was that the fact sheets cannot be used by extension workers as a base for recommendations, because reliable decision-making by farmers based on one single or few experimental setups can be difficult. The general opinion across countries, and participant categories was that the short-nature of the experiments limited the chances of obtaining more robust results for promotion and policy-making, and that most of the benefits and challenges from these interventions are likely to be observable only in the long term. Therefore, long-term studies of changing land use management are needed to get reliable arguments for soil saving cropping systems. But it was also acknowledged that it was only possible to do so much within a project timeline of five years, and that the results do reveal potential possibilities, which if supported properly could contribute in enhancing soil quality with increased productivity in the years to come.

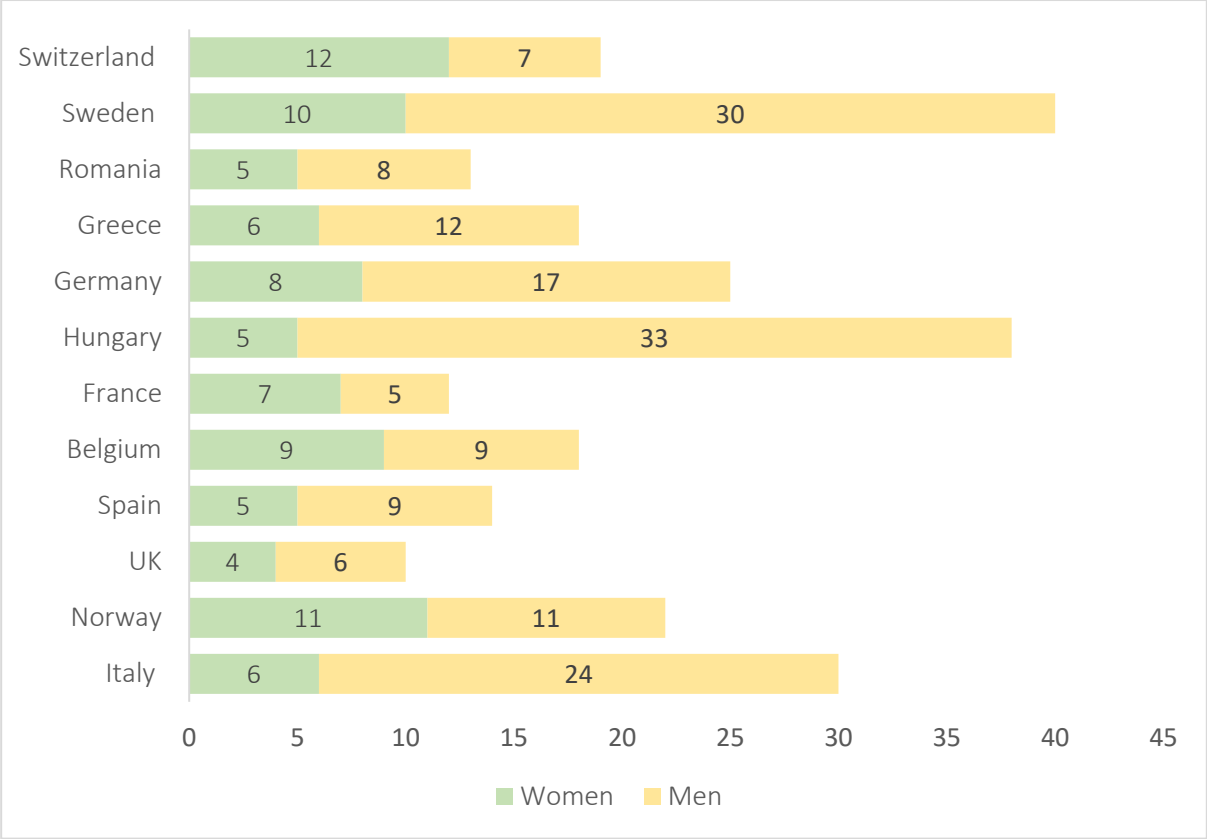
Stakeholder participation and gender representation

The SoilCare project in general has been conscious about the need for considering and maintaining a reasonable gender participation ratio throughout the duration of the project. It has been careful in engaging as many women representatives across different stakeholder categories as possible, with some degree of success in some project sites. This section presents the overall participation in the Final Stakeholder workshop, but with special focus on women. As is evident from Figure 4 there was a wide degree of participation and representation during the workshop. In absolute terms, the number of participants in the workshop ranged from 10 (UK) to 50 (Portugal) (see Annex1). As far as the gender representation is concerned, it was heavily skewed in favour of male participants[7]. The exceptions are Norway and Belgium, which had equal representation (50%) of both men and women participants (11 and 9 respectively). In the

[7] The disaggregated data in the form of gender-break and categories of stakeholder participation is presented only for those countries which was provided these different breakdowns. For a broad overview of participation across countries see Annexure 1

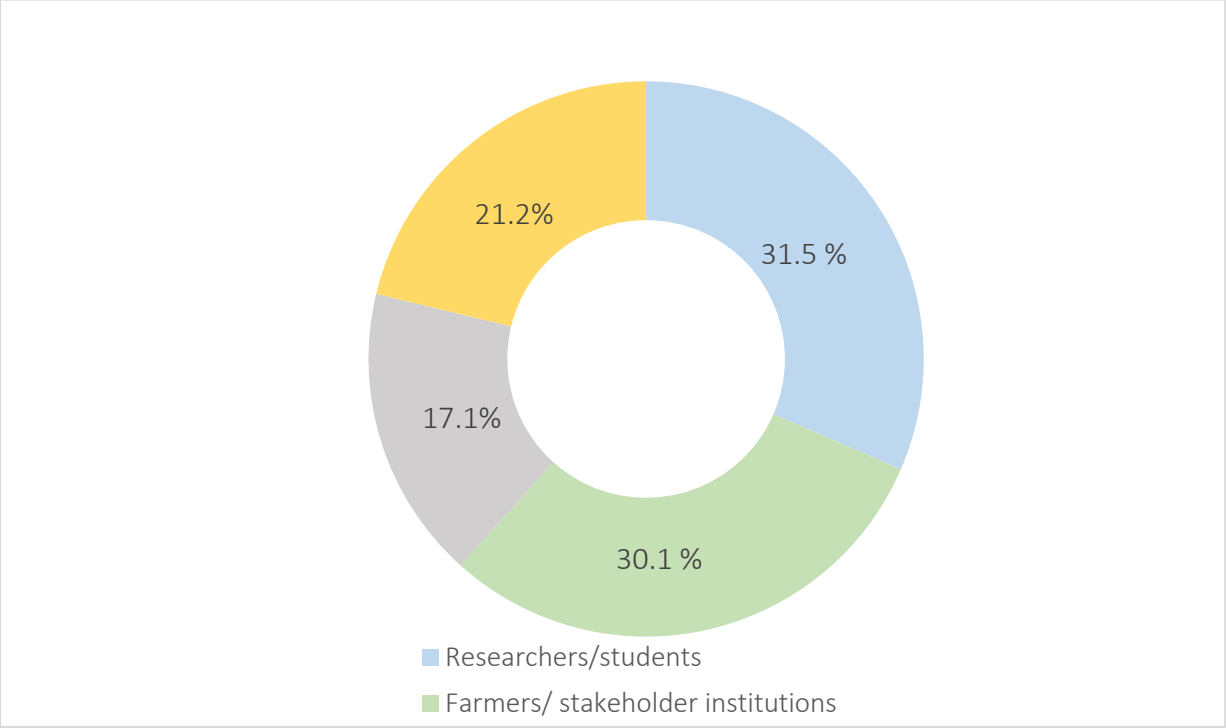
case of Hungary, representation of women was as low as 13% whereas France recorded a greater participation of women at 58% of the total participation.

Figure 4: Gender representation during the Final Stakeholder Workshop



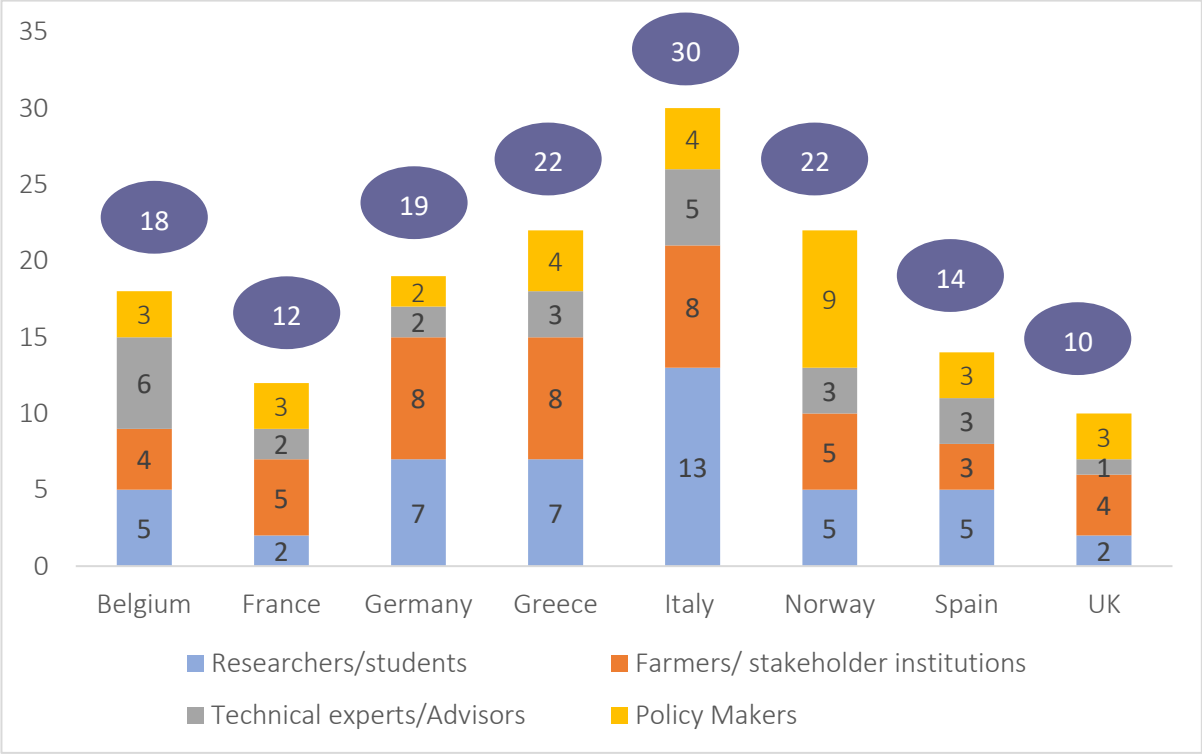
Four broad categories of participants attended the Final Stakeholder workshop. In the majority of the partnering countries, the maximum number of participants were from the research and the farming community (see Figure 5). Some of the stakeholder institutions referred here are organisations who are directly or indirectly affected by any developments in the agriculture sector (e.g. National Farmers Union (NFU, England), Game & Wildlife Conservation Trust (GWCT, UK, Associations and cooperatives for sharing equipment, organic/biodynamic agriculture (e.g. France)

Figure 5: Participation by different stakeholder categories across countries



The only exception was Norway (see figure 6) where participation from policy makers was relatively higher.

Figure 6: Country-wise breakdown of stakeholder categories



Impacts that have happened so far

This segment of the workshop aimed at understanding the kind of benefits and impacts that have happened as a result of the SoilCare project in the research site. Through an interactive and deliberative session, participants shared their ideas about the benefits and impacts from the project by giving specific examples. The following are the country-wise benefits and impacts that have arisen out of the SoilCare project (See Table 2). Some of the project partners and the workshop participants within could outline the direct, visible and measurable benefits spinning out from their project site, such as Belgium, Greece and Spain. On the other hand, project partners such as GWCT from the UK were still unsure about the impact from SoilCare project, as the results for them are just beginning to emerge.

Table 2: Country-wise impacts from SoilCare project

Country	Impacts
Belgium	There have been many spill-over impacts from this project which has enabled the constitution of three new initiatives around soil conservation. These are 1) The project *"Landbouwers-koolstofbouwers"* (Farmers – Carbon farmers, 2019 in collaboration with Regionaal Landschap Zuid-Hageland and nine municipalities was started to widely roll out a number of agricultural measures that have proven effective in terms of soil quality and carbon storage in the soil. 2) The project "*Koolstofboeren*" (Carbon Farmers) started in 2020 in collaboration with Boerennatuur aims to encourage and support farmers to integrate carbon storage as an important part of their business operations, including the development of a result-oriented compensation system that compensates farmers for providing ecosystem service of carbon storage; and 3) Project "*Bierbeekse boeren doen aan circulaire koolstofopbouw"* (Bierbeek farmers doing circular carbon sequestration) will be started in 2021 in the municipality of Bierbeek on the initiative of (SoilCare stakeholder).
France	SoilCare work provided a good basis to foster discussions amongst farmers on soil, especially in peer-to-peer learning groups. The constitution and guidance of these groups were supported in France by different instruments (e.g "30 000 groups"). After several years of working together in the SoilCare project, the stakeholder panel is still dynamic. Although the national organic trade fair was cancelled in 2020, all stakeholders reaffirmed their commitment to meet even after the end of the SoilCare project
Germany	The SoilCare project has helped tremendously in connecting various stakeholders and raising awareness of soil-improving cropping systems. It has enabled exchange with

Country	Impacts
	policy makers and adaptation of FAKT[8] measures for better soil protection (science, agricultural administration). As compared to before, the use of cover crops and reduced tillage is better practiced and monitored in some areas (e.g. Baden-Württemberg).
Greece	A woman Olive farmer based on SoilCare project's observations has already expanded the no-till treatment to new fields, achieving reduced soil erosion and unexposed tree roots. The vineyard farmers (a man and 2 women), gained better understanding of their cultivations and soil functions and how the inexpensive vetch cover crops could provide protection against soil erosion. More importantly, the acknowledgment from some farmers that through this project they came to know about the Sustainable Development Goals (SDGs), and how farming practices is intricately related with some of the outcomes of SDGs.
Hungary	Non-inversion tillage, cover crop production and mulching with straw have been adapted in many farms. In addition, importance of crop rotation is more and more recognized for its beneficial effect on pest management, soil conservation and biodiversity.
Norway	The SoilCare project has been an important contributor in increasing the general focus on cover crops in Norway, both amongst farmers and the general public. Cover crops used to have a "bad reputation" amongst farmers, but as a result of the project that perception is slowly changing. The project has also been useful for building networks both nationally and internationally (the latter primarily applicable for researchers).
Poland	Recognition from most stakeholders that they learnt something new related to SICS and how small, additional measures, often inexpensive can help enhance soil quality and profitability. Many acknowledged how this project has enabled networking with soil experts and advisors. Others valued the experience of collaborating in an international project and co-learn from the experiences of other project partners in Europe.
Portugal	New knowledge about mycobiome and broadening of knowledge of SICS and the impact of different agricultural treatments on soil quality. In particular, the Legume Cover Crop (LCC) species (treatments) showed good adaptation to the regional conditions, producing high amounts of dry matter (especially in clover species). However, inter and intra species variability seemed very high due to the influence of many parameters (e.g. precipitation)
Spain	There were positive impacts of cover crops on different aspects on the estate itself and on the environment, such as the reduction of possible pests, a decrease in the carbon footprint, as well as an increase in soil biodiversity. Specifically, in the case of stone fruit, those managing the estate have decided to establish a continuous deficient irrigation system; thus, reducing total water consumption by 25% over the course of the year. The main impact achieved is that the managers of the estates where the experiments were conducted have opted to incorporate the methods evaluated in the project or at least an adaptation of them.

[8] Largest agribusiness company in Germany

Country	Impacts
Sweden	The findings from various field research (e.g. optimal levels of pH and phosphorus) are already influencing the agri-business sector. In addition, implementation of some of the SICS by farmers are increasing yields which is financially supporting this change in agricultural practices. Acknowledgement of indirect benefits (network of soil experts)
UK	Participants struggled to identify specific benefits to them arising from the SoilCare project to date, as results from the project are only now becoming available to them.

Overall, the nature and scale of impacts achieved as part of the SoilCare project so far has been quite varied. It ranged from further adoption of experimented SICS beyond the experimental sites to upscaling, network building and developing and building new initiatives. For instance, farmers and advisors in Spain who were concerned about water-intensive crops and plantations, were quite impressed with what the water-deficient irrigation system could achieve in the short experimental phase. The findings from the site experiments seemed to be having a cascading effect in convincing other farmers. One of the advisors made the following comment

> *"I think it's incredible that this experience has made it possible for the grower to reduce total water use by 25%. This is a huge step as it will greatly reduce water costs. Moreover, you can also lower the cost of phytosanitary products because there will most likely be fewer pests and diseases"*

The farmers and researchers, however, were of the view that going forward it is important to keep a check whether there is any drop in yield because of less use of water. Belgium, interestingly through the three different initiatives (*"Landbouwers-koolstofbouwers*"; "*Koolstofboeren*" and *Bierbeekse boeren doen aan circulaire koolstofopbouw"*) seemed to be gearing towards tapping the future soil carbon market.

Potential Future Impacts

This segment of the workshop through a deliberative process aimed at understanding how the project findings could be used in a way so that more and more people can benefit from them. Secondly, how the individual country teams could be assisted and supported so that their findings can get a wider acceptability across interests groups and effectively implemented on a much wider scale.

Table 3: How to stimulate future impacts of SoilCare findings

Country	Future Impacts
Belgium	The three initiatives (see table 2) around their stated objectives aim to enhance the soil carbon status. The long-term future impact from this project is that it can catapult Belgium as a potential player in the future soil carbon market.
France	For future impact, there was a consensus among stakeholders to pursue and diversify dissemination activities (short videos on SICS for events like 'Soil Day'), organise different events (4 planned across 4 different departments). There were thoughts on creating and maintaining a 'community of practice' around soil and bring all the soil-related experts and stakeholders from the project. A collaborative project has been initiated already in Brittany (Loire-Atlantique) in a framework similar to that of the SoilCare project. Plans are on to extend this model partnership to all this surrounding region (Pays de la Loire)
Germany	The participants were in agreement that the project findings in future can be useful for teaching, lectures and organising workshops with the farming and the policy making community. However, the booklet on '10 common mistakes' developed and disseminated as part of the project output is common knowledge for most farmers. There was an emphasis on being clear who the target audience is of such dissemination material is. However, most participants were of the opinion, the administration could forward the booklet to vocational schools to raise awareness about soil health. For extension service, it was pointed out that field days on demonstration farms could be organised for spreading research findings among farmers. Measures could be taken to convince agricultural administration and policy makers to support the findings of the policy summary.
Greece	Different olive and vineyard farmers, both male and female, were interested in extending no tillage practice and crop rotation to additional plots of their land. Same with the orange farmers who was convinced about the benefits of less water intensive avocado crop is planning to extend the area as well as monitor results for systematic analysis. This is likely to have encouraging effects on other farmers in the region to adopt these SICS measures. The consultants, three males, were motivated to use the results and present them in workshops and/or other organized events aimed at farmers. Some of the involved researchers, a female and three males, proposed to

Country	Future Impacts
	disseminate the information about the new effective SICS to their partners, as well as to create synergies with SoilCare project. Other researchers, two males and a female, were interested to monitor the study fields for another 2-3 years, with the agreement of the farm owners, to examine if soil erosion continues to decrease in the SICS plot and at what rate.
Hungary	Non-inversion tillage, cover crop production and mulching with straw have been adapted in many farms. Along with crop rotation the plan is to expand it to other adjoining region and explore reasonable funding sources for the same.
Italy	Future research on SICS should include farmers in the team. Technicians asked for more result sharing, in the form of articles, on-field demonstration activities and meetings. They called for a clear protocol to evaluate SICS performance at farm scale.
Norway	For wider acceptance and future impacts of cover crops, which had shown positive results, the plan was to rope in policy makers, farmers and government authorities. But it was acknowledged that future impacts are contingent on funding for more research in order to produce more evidence for effective policy making.
Poland	The Polish stakeholders had the following suggestions as to how to encourage future adoption by famers a) financial support; b) Provide support by providing precise advice and timely information on the activities to be implement, and the 'when' and 'hows' of it c) Farm subsidies/ministerial subsidies; d) enable collaboration with companies for large-scale implementation of results
Portugal	Future studies should investigate the long-term impacts of Legume Cover Crops on soil fertility and weed control. Use of urban showed good results (see table 1), however for any future impacts concerns were raised around the lengthy administrative process for the approval of Sludge Management Plan, which discouraged interested farmers. Need for more dissemination seminars that can address traditional reservations around sludge use. Sludge treatment is expensive (odour removal) but it can be addressed by incentivising farmers through financial support.
Spain	To ensure future impacts there was consensus on the need to tap in the 'Growers association' as they could influence a significant number of actors in effective adoption and practice. Also, that future impact on soils from a sustainability point of view would get impetus with the coming of the European Green Deal and the 'Farm to Fork Strategy' strategy as that would call for the reduction in the use of phytosanitary products, fertilizers and so on and encourage trend towards organic agriculture. Those into SICS practices are likely to have a business advantage.
Sweden	It was recognised that experiments need to be repeated at other sites in different soil type combinations and crops. This is because there was a concern regarding the general applicability of the findings. The issue of funding was raised in order to achieve some robustness in findings. Additional future impacts could be that the findings from the study could feed into the new tool used by Swedish Extension

Country	Future Impacts
	service "Odlingsperspektivet" that calculates changes in carbon post introduction of new innovative soil practices. Also, that future impacts are contingent on taking the SICS messages far and wide through use of social media, audio-video tools and writing short articles in journals and magazines read by farmers and extension scientists
Switzerland	Need to make knowledge on SICS more easily available to interested farmers. Future impacts are dependent on extensive dissemination through journal articles , brochures and leaflets during events, publication on websites dedicated to consumers, both private and the public sector have to play a proactive role in extending knowledge and information across different scales (national, regional, international) as well as to the different consumer groups
UK	Deep rooting experimentation findings has shown potential signs of being up scaled to wider audience. For instance, mixed arable, livestock farmers and plant breeders can be encouraged to explore this particular SICS. For its ecosystem services, even policy makers can be explored to include deep rooting practices in future agri-environment schemes (AES). There are positive signs, however, more research is required before it can be advocated to more stakeholders with certainty.

As is evident from Table 3, discussions around potential future impacts revolved around five broad categories

a) Up scaling of existing impacts from SICS, roping in boundary organisations (e.g. Growers Association)
b) Need for long-term studies, across different soil types, crops and climatic conditions for more evidence-based decision making
c) Need for financial support to incentivise interested farmers to adopt the practice.
d) Dissemination strategies that cut across departments and is planned on both short term and long-term basis (events, networks), media (audio-visuals, factsheets)
e) Education, awareness and capacity building of the key actors and stakeholders

But overall this sums up the general thought processes of the farmers and Farm Advisors/ Technical Experts as far as SICS are concerned

> *"I truly believe that the future of the use of this type of practice depends on whether the commercialization of production is economically profitable under these specific conditions. As long as this is not the case, and it is simply superficial aid or greening payment, it won't go anywhere."*
>
> - A participant from Spain

Policy relevance of the findings

Many of the measures suggest policy relevance and could benefit from timely interventions and support. For instance, some of the existing legislations were contradictory, inconsistent and could impede potential progress as far as adopting specific SICS is concerned (e.g. woodchips in the case of Belgium) and there is a call to remove barriers and include the findings of SoilCare to amend and/or adapt legislations that can enable a transition towards a sustainable soil pathway. The following table 4 compiles the wide range articulations from a policy perspective from different project sites[9].

Table 4: Country-wise suggestions for SICS-related policy support

Country	Policy
Belgium	Removing the barriers- 1) Resource level - wood chips availability issue, encourage planting and maintenance of wood hedges 2) Lack of information - incentivise more research, more demonstration and dissemination; 3) Inconsistencies in legislations- adapt legislation and make it coherent; 4) Costs- incentivise, compensate in the form of carbon credits and biodiversity management; 5) Establish mechanisms for effective knowledge transfer and exchange (e.g. farmer establishing cooperation with the wood and the forestry sector)
France	7 policy recommendations 1) Involve farmers in policy design & implementation; 2) engage with farmers and trusted organisations to deliver advice; 3) revise the existing policy framework to include long term targets; 4) Consider the development of dedicated soil policy; 5) Offer regular training and information services to keep farmers informed; 6) Provide tailored support to farmers transitioning to sustainable practices; and 7) Introduce more targeted financial incentives.
Germany	Stakeholders in Germany highlighted that market forces and mechanisms created an environment favouring intensive agriculture. With its well-established systems and supply chains, intensive agricultural production was economically more attractive to farmers than the income generated through sustainable practices, at least in the short term. Short-term monetary conversion assistance contradicts the slow-term planning capability that farmers need. Support programs should be designed for the long term (and not just as start-up aid) to give farmers planning security.
Hungary	Existing legislation enable as well as limit adoption of SICS. Several policies cover the SICS trialled at the study site. For instance, cross-compliance requirements and greening measures established under the CAP incentivise farmers to adopt crop-

[9] For more details on policy, there are country reports for each site. In addition, D7.1 and D7.2 provide discussions on barriers and incentives as well as horizontal analysis and overarching policy recommendations respectively. All these reports can be found at the following link https://www.soilcare-project.eu/resources/deliverables

Country	Policy
	rotation practices. Similarly, nutrient management is regulated through various pieces of water legislation which establish limitations on or requirements or fertiliser (and pesticide). There were suggestions on support for buying new equipment.
Greece	Institution of favourable policies to encourage uptake of SICS; Subsidy for machineries (e.g. ploughing machine for better tillage depths, shredder) and free or subsidised supply of good quality vetch crops. Support for trainings, opportunities to establish collaborations between researchers/scientists
Italy	There were suggestions from technicians on the need for a simplified legislation to regulate subsidies. That policy makers could play a proactive role in enabling dissemination of positive results from the SoilCare project, and create new subsidies for SICS implementation
Norway	For wider acceptance of cover crops (which traditionally has had a bad press), policy makers and relevant government authorities have to play a more proactive role.
Poland	The policy makers could help with the following to increase the uptake of sustainable soil management practices: a) Support information providers that farmers respect and trust e.g. farmer influencers or advisers; b) Support farmer networks that are open to trying new things – e.g. innovative farmer networks; c) Address power inequalities (e.g. farmer to landowner) through expert facilitation of multi-stakeholder groups and long-term contracts; d) Incentivising cooperation and collaborative approaches; e) Supporting trusted, unbiased external Agencies as facilitators that will aid the development of multi-stakeholder soil management groups; f) Clearly define a methodology for monitoring the SDGs and coordinate a standard approach, institute guidelines and quantitative targets to reduce soil degradation; and h) Promote regionally-specific good practice via SICS and enable transitions to holistic SICS methods for all farmers through policy support
Sweden	For long term studies on SICS (as is the recommendation in Sweden and most sites), there were articulations around inadequate funding that could support future studies. Policy makers could look into this aspect.
Switzerland	The adoption of the SICS is contingent on addressing the following issues (i) awareness generation amongst farmers about the impact of using pesticides on environmental, animal, and human health, and (ii) financially support farmers in moving towards complete transition to sustainable soil practices. Existing policies needs streamlining to enhance and accommodate sustainable soil practices
UK	Deep-rooting- Potential use of the research findings with wider audience, including mixed arable and livestock farmers and plant breeders. Policy makers could help integrate deep rooting techniques as part of agri-environment schemes (AES).

Conclusion

There have been wide range of experiences from different sites, with some sites experimenting against a singular soil threat and others who worked to combat two or more threats. Concerns around declining soil organic matter (SOM), soil compaction and soil erosion were the three predominant threats against which different SICS as potential solution was experimented upon. This has also meant the number of SICS findings experimented varied from site to site and so are the findings. Belgium for instance, based on the SICS engagement and findings from the project seemed to be gearing towards future carbon market whereas others (e.g.UK) had trouble making complete sense of the findings for any reasonable conclusions. But overall it can be summed that the findings were:

- Mostly in line with what was anticipated by most stakeholders
- There were concerns around extrapolation of findings given the limited sample size and short duration of the project
- The broad suggestion was on extending the scale and duration of the site experiments across different soil types, crops and climatic conditions to be able to draw more conclusive conclusions.
- In terms of impact, the project has tremendously helped in connecting various stakeholders (soil experts, advisors, policy makers) and raising awareness of soil-improving cropping systems. In addition, most stakeholders acknowledged that they learnt something new related to SICS and how small, additional measures, often inexpensive can help enhance soil quality and profitability.
- There was a wide range of articulations for policy intervention, but the general concerns were around better funding support for more research, machinery including incentives and subsidies to adopt more SICS measures
- Finally, the call for devising of appropriate mechanisms, guidelines and processes, removing inconsistencies in legislations that can streamline and enable effective SICS adoption and shift towards a more sustainable agriculture pathway

Some of the farmers were also keen on being part of research teams so that they can contribute in co-producing knowledge and there is a general buy-in of research and policy outcomes.

APPENDICES

Appendix 1

Country-wise participation in the Final Stakeholder Workshop

Countries	Women	Men	Total Participants
Belgium	9	9	18
Denmark*	-	-	-
France	7	5	12
Germany	8	17	25
Greece	6	12	18
Hungary	5	33	38
Italy	6	24	30
Norway	11	11	22
Poland#	-	-	19
Portugal#	-	-	50
Romania	5	8	13
Spain	5	9	14
Sweden	10	30	40
Switzerland	7	12	19
UK	4	6	10

*Denmark- data not available

Gender break-up not available

Appendix 2

Online workshop Photos

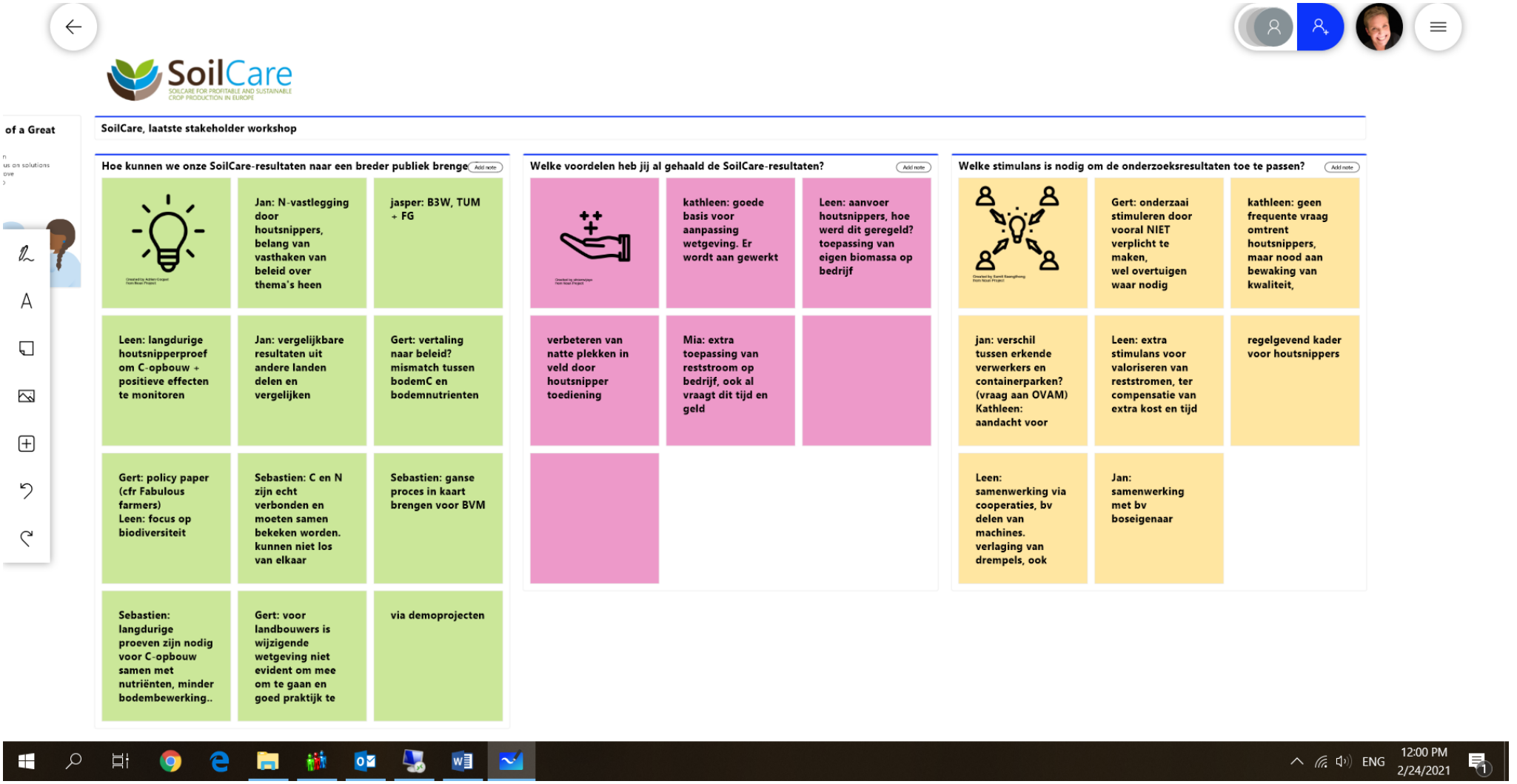
Belgium

On-farm 'Soil Day' at Campbon in the Loire- Atlantique Department
(26th march 2021)

France

Appendix 3

Written feedback to the policy summary



Appendix 4

FINAL STAKEHOLDER WORKSHOP (COUNTRY REPORTS)

BELGIUM

SoilCare Final stakeholder workshop

15/2/2021 – 13u-15u – online (Teams)

Participants

Present:

Davy Vandervelpen (M):

- Organisation: Soil Service of Belgium; Farmer (Bekkevoort)
- Type: Advisor / Researcher / Farmer
- Interest: Research and advisory in agriculture and horticulture

Jasper Somers (M):

- Organisation: Praktijkpunt landbouw Herent (Province Vlaams-Brabant)
- Type: Advisor
- Interest: Practical research and advisory on soils and fertilization

Katleen Van den Eynden (F):

- Organisation: OVAM (Openbare Vlaamse Afvalstoffenmaatschappij)
- Type: Policy maker, Flemish government
- Interest: OVAM team bio; Action plan on biomass (residual) flows: legislation regarding the use of wood chips in agriculture

Leen Vervoort (F):

- Organisation: Boerennatuur Vlaanderen
- Type: Advisor
- Interest: Aiming at sustainable agriculture and circular use of residual flows such as wood chips

Sebastien Janssens (M):

- Organisation: Flemish Land Agency (VLM), manure policy
- Type: Policy maker, Flemish government
- Interest: Involved in the B3W project: guiding farmers to a better fertilization and soil care.

Martien Swerts (F):

- Organisation: Departement Omgeving (Environment), team Soil protection
- Type: Policy maker, Flemish government
- Interest: Leads the team Soil protection

Gert Van de Ven (M):

- Organisation: Hooibeekhoeve, Landbouwcentrum Voedergewassen
- Type: Advisor
- Interest: Practical research and advisory regarding fodder crops; support for the implementation and follow-up of the SoilCare trials on maize

Jan Vandervelpen (M):

- Organisation: Farmer (Bierbeek) / Municipality of Bierbeek
- Type: Farmer / Municipal government
- Interest: Organic fruit grower (apples, pears); alderman of agriculture of the municipality of Bierbeek, initiator of a project in Bierbeek concerning the circular use of residual wood chips flows in agriculture within the municipality.

Organisators / facilitators (Soil Service of Belgium):
Annemie Elsen (F);
Mia Tits (F);
Helena Vanrespaille (F).

Introduction

Summary of the aims of the workshop (as included in the invitation)

In the European Horizon2020 project SoilCare, cropping systems and techniques are studied that can contribute to the improvement of soil quality and at the same time to the profitability and sustainability of agriculture in Europe. The project is a collaboration between 28 partners from different European countries and is coordinated by WUR (Wageningen University Research, The Netherlands). In Flanders, the Soil Service of Belgium is responsible for the development and monitoring of a study area located in the municipalities of Lubbeek, Bierbeek and Boutersem, east of Leuven. The Soil Service of Belgium is responsible for the implementation and follow-up of promising cropping systems and is responsible for the productive cooperation with all Flemish stakeholders.

After a difficult year 2020, the SoilCare research in Flanders is now gradually ending. It is now important to list all the results and to draw conclusions from our experiences with soil-improving cultivation systems.
During this project, we also called on your knowledge and expertise with regard to soil-improving cultivation systems. That is why we would like to invite you to the final SoilCare Stakeholder workshop that will be held on-line on Monday, February 15 at 1 pm and will last approximately 2 hours.

Agenda:
- Introduction
- Presentation and discussion of the final research results
- Validation and utility of the results by stakeholders
- Information and dissemination
- Take-home message
- Closing word

Date and location
Monday February 15th, 2021, 13-15h; on-line meeting

Presentation and discussion of the project results
See also the attached PowerPoint presentation (appendix).

Application of organic soil amendments

In the past, we have already had the necessary experience with compost and farmyard manure. Wood chips were a novelty and were tested with a view to circular use of management residues from wood edges.

Biophysical trial results

The soil amendments were applied in autumn, before the sowing of winter wheat.
The soil organic carbon content was not measurably different within the timeframe of the SoilCare project. As part of other demo projects, the effects of organic soil improvers were also simulated with the Cslim application of the Soil Service of Belgium. These simulations clearly showed the potential of wood chips regarding organic carbon build-up in the soil.
For the infiltration rate, it was expected that the wood chips would already have a positive effect in the short term, because the undecomposed organic material can absorb rainwater more easily. In 2019 in particular, the infiltration was significantly higher than the other treatments. The same trend was visible at a repeat in 2020, but there were no significant differences due to the unfavourable weather and soil conditions for performing the measurements.

In the short term, the favourable effect of the application of organic soil amendments on the aggregate stability and the bulk density of the soil was not visible, although the results were on average more favourable for the treatment with wood chips.

In spring after the application of the materials, there was still no clear effect of the treatments on the mineral nitrogen in the soil. One year after the application of the organic soil improvers, the effect became clear. The mineral nitrogen in the soil was significantly lower that autumn in the plots with wood chips, due to (temporary) nitrogen immobilization. Two years after administration, the same trend was visible, but less clearly defined.
Winter wheat was sown shortly after the organic soil amendments were applied. In the plots with wood chips, wheat emergence and initial development was poorer than in the other plots, which is clearly visible on a satellite image from May 2018. This was probably due to physical obstruction of the germinating plants by the wood chips. These differences had disappeared at the harvest and there were no significant yield differences. In the following years, there were no more differences in winter barley or in the potatoes.

Socio-cultural and economic indicators

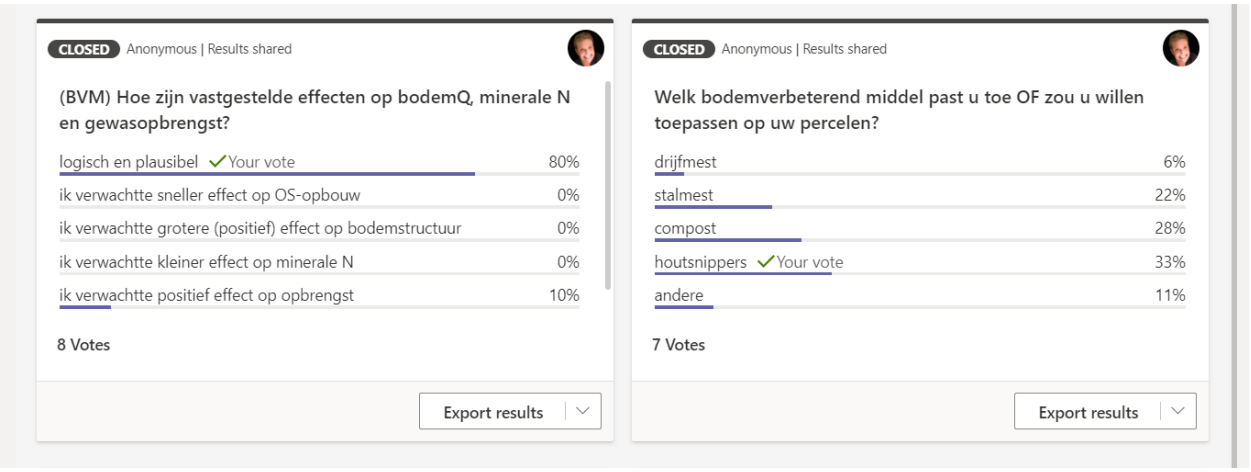
The evaluation of the socio-cultural and economic indicators focused on the application of wood chips.

The positive and uncertainties or negative points of the wood chips application were identified based on interviews with farmers, field researchers and advisers. The improvement of soil quality and soil resilience, better crop yield in the longer term, the valorisation of residual waste and erosion prevention were highlighted as positive. Uncertain or negative points are the uncertainty of the nitrogen fertilization (although this should not be a problem if the nitrogen availability in the soil is properly monitored and the nitrogen fertilization is adjusted), the risk of poor crop emergence or even crop failure in case of improper application, risks of the introduction of diseases and weeds (e.g. when using residual waste from intercommunal waste companies), the extra costs and workload and the limited availability of wood chips.
The following barriers and potential incentives were listed:

- barrier: limited availability of wood chips - incentive: encourage planting and maintenance of wood edges;
- barrier: lack of information - incentives: continue research, organize demonstrations, disseminate information
- barrier: inconsistencies in legislation - incentive: adapt legislation
- barrier: cost (general) - incentives: incentives such as management agreements, compensation for the provision of ecosystem services e.g. carbon credits
- barrier: cost of shredding (machines) - incentive: cooperative purchase of machines

Validation and usefulness of the results

The participants rated the validation and usefulness of the trial field results using 2 live polls.



1. What do you think of the observed effects on soil quality, mineral N and crop yield?
   - Logical and plausible: 80%
   - I expected a faster effect on SOM build-up 0%
   - I expected a greater (positive) effect on soil structure 0%
   - I expected a smaller effect on mineral N 0%
   - I expected a positive effect on yield 10%
   - I expected a negative effect on yield 10%
2. Which soil amendment do you use OR would you like to apply on your fields?
   - Liquid manure 5%
   - Solid manure 22%
   - Compost 27%
   - Wood chips 33%
   - Other: bokashi, composted wood chips 11%

Discussion

General evaluation of validity and usefulness:

- The trial results were considered logical and plausible by most participants. 1 participant expected a positive effect of the soil improvers on the yield and 1 person a negative effect.
- Wood chips, compost and farmyard manure were considered by most of the participants as the most promising materials for improving the soil. In addition, Bokashi and composted wood chips were also mentioned as possible soil amendments.

Other comments and questions:

- Leen Vervoort (advisor, F): It would be interesting to have long-term trials with wood chips to follow up the build-up of soil organic matter.
- Jan Vandervelpen (farmer, M): are there comparable results regarding the use of wood chips from the other SoilCare partners?

Annemie: In Spain, wood chips from tree pruning were used in fruit orchards, mainly as mulch against erosion.

Mia: In a current Leader project, cleared fruit trees were grinded/chipped and incorporated into the soil by Pcfruit. The effects of this are being monitored.

- Jan Vander Velpen (farmer, M): The application of wood chips fits both the nitrogen and the carbon story. Farmers are triggered both by their effect on nitrate residues and by the carbon build-up.
- Leen Vervoort (advisor, F): Partnerships between farmers and the cooperative purchase of machines can remove the bottleneck of availability of materials and workload.
- Jan Van der Velpen (farmer, M): For the availability of wood chips, we can go even further, for example with cooperation with the forest and wood sector.

Soil cultivation and soil cover in maize

Biophysical trial results

The trial was carried out successively on two different fields: in Lovenjoel and in Bekkevoort. The treatments in these trials consisted of:

- Conventional ploughing
- Non-inversion tillage
- Striptill
- Grass undersowing

In the field trial in Lovenjoel, maize was sown after a cover crop of rye. This is a frost-resistant cover crop that had to be destroyed after winter before the striptill could be carried out. The destruction was done in 2 ways: spraying with herbicide (Roundup) or flailing, with which the rye was not really killed. The experimental field had a history as converted grassland, resulting in strong wireworm infestations, especially in the striptill treatments, where grass residues remained on the soil. The grass under-sowing was carried out simultaneously with the maize sowing in this field. Tall fescue was used for this, because of the slower emergence of this species, which would therefore be less competitive for maize. However, the emergence and growth of the fescue was strongly inhibited, probably due to poor sowing conditions on the one hand and inappropriate weed control on the other. The **infiltration rate** was measured in the Lovenjoel trial and was not significantly different between treatments. The **aggregate stability** was slightly better in the striptill treatments, but the differences were not significant.

The amount of **mineral nitrogen in the soil profile** in the first autumn after the establishment of the trial in Lovenjoel and in the following spring was not significantly different between the treatments. In autumn of 2019, the nitrate residue was significantly higher in the treatment with striptill, where the maize was very poorly developed and had absorbed less nitrogen.

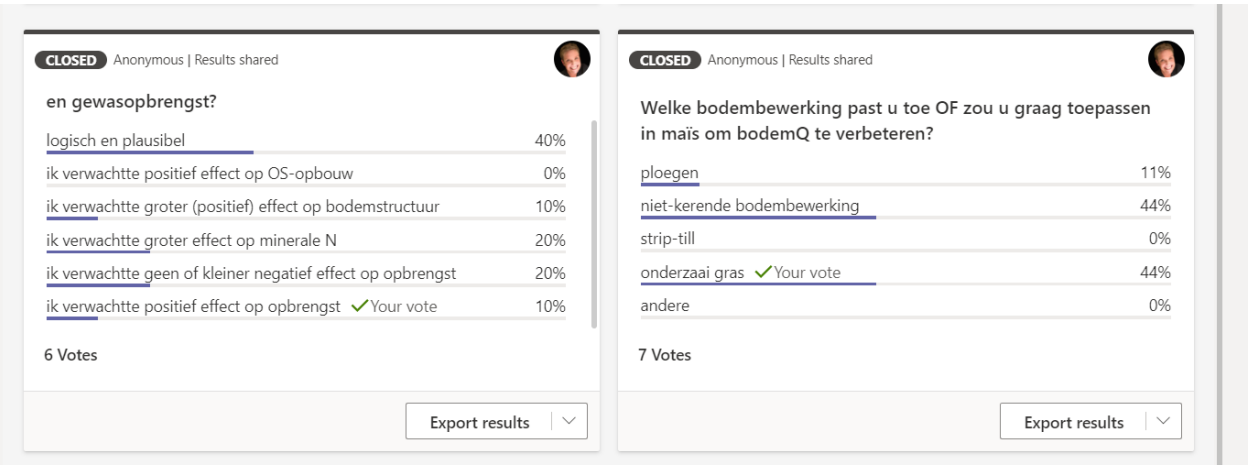
Crop development and yield were lower in the striptill plots and that led to higher nitrate residues. The wireworm infestation was strongest in both treatments with striptill, especially where the grass cover crop was flailed and not killed by herbicides. Because of the disappointing results in Lovenjoel, the trial was established again in 2020 in another field in Bekkevoort, this time in a cover crop of yellow mustard and phacelia. Since this cover crop is frost sensitive, no herbicide treatment was needed to destroy it. In consultation with the expert Gert Van de Ven

(Hooibeekhoeve), the grass undersowing in Bekkevoort was carried out later, 5 weeks after the maize sowing. A mixture of ryegrass and *Dactylis glomerata* was used, with a faster initial growth than tall fescue. Due to the drought after the grass sowing, a less good grass emergence was observed here too, although clearly better than in the first trial in Lovenjoel. In this experiment the **emergence and initial development** of the maize was also less good in the striptill plots. However, this was not due to wireworm infestations, but rather to an inaccurate maize sowing in the tilled strip: in some places the maize was sown next to the tilled strip, instead of in the middle of it. However, the dry matter **yield** was no different from the other treatments.

After the maize harvest, the under-sown grass was damaged by the harvesting machines. However, other tests with undersowing carried out by Hooibeekhoeve do not show this to be a general trend and the grass usually catches up quickly in the following weeks. Also important is the underground root development, which is less visible to the eye, but is indeed greater with undersown grass than with grass sown after the maize harvest. Hooibeekhoeve is generally positive about the effect of grass undersowing on the **nitrate residue** and **root development** of the grass. Undersown grass absorbs more nitrogen in autumn and winter and has a better-developed root system, which means that more **organic carbon** is also supplied after the incorporation of the grass in spring.

Validation and usefulness of the results

The participants rated the validation and usefulness of the trial results using 2 live polls.



1. What do you think of the observed effects on soil quality, mineral N and crop yield?
   - Logical and plausible 40%
   - I expected a more positive effect on soil structure 10%
   - I expected a greater effect on mineral N 20%
   - I expected no or a smaller negative effect on crop yield 20%
   - I expected a positive effect on crop yield 10%

2. Which soil cultivation technique do you apply OR would you like to apply in maize to improve soil quality?
   - Ploughing 11%
   - Non-inversion tillage 11%
   - Striptill 0%
   - Grass undersowing 44%
   - Other 0%

Discussion

General evaluation of validity and usefulness:

- 40% of the participants thought the trial results were logical and plausible. The opinions of the other participants were divided: they expected a greater effect on the soil structure, a greater or lesser effect on the yield or a greater effect on the mineral N in the soil.
- Grass undersowing was considered by most participants as a promising technique for improving soil quality in maize. On the other hand, there was no enthusiasm for the striptill technique.

Other comments and questions:

- Gert Van de Ven (advisor, M): Not sowing accurately in line with striptill does indeed cause major problems. The wireworm problem is not new and there are concerns about the loss of crop protection products. Non-inversion tillage requires combinations of products to control wireworms. Current products score too poorly to do this.
- Gert Van de Ven (advisor, M): After the maize harvest, undersown grass will catch up quickly, but maybe not in time to limit the nitrate residue. The positive effects of grass catch crops on nitrate residue and root development are greater with undersowing than with sowing after the maize harvest.
- Gert Van de Ven (advisor, M): For striptill, RTK-GPS is required with an accuracy of 2 cm, not 30 cm. In Huldenberg striptill gave problems because the machines slipped away on the slopes. Striptill is more suitable on flat sandy soils (but less useful because on these soils there is less erosion risk).
- Davy Vandervelpen (advisor/farmer, M): Grass undersowing is not easy to apply in practice and our experiences are not so positive, but I would not count out this technique. The fields where the grass is not intended for mowing and / or where later maize varieties are sown, will be harvested later in the season and then you often cannot sow grass afterwards anymore. Grass undersowing should therefore be seen as a contribution to soil organic matter and, as Gert indicates, its effects on the nitrate residue will only manifest itself later in the season (after 15/11).

Policy in Flanders regarding soil and soil quality

Policies in the different study sites were examined by SoilCare partner Milieu and a policy brief was drawn up for each study area.

Interfaces of policies with soil-improving cropping systems

The investigation of policy in Flanders showed that the soil improving cropping systems studied within SoilCare are linked to multiple legislations and policy measures. The cropping systems that were studied in the Flemish study area (resp. cover crops, soil cultivation and integrated nutrient management) are linked to 6 different measures / legislations:

- CAP cross compliance
- CAP greening payments
- CAP agro-environmental measures
- Manure Decree
- Decision on Erosion Control
- VLAREMA

Policy recommendations

The recommendations for Flemish policy that were formulated from SoilCare are:

- Increase policy coherence, especially regarding soil specific and stimulating measures, better coordination between departments. Work more soil specific and stimulating.
- Reward farmers for the benefits they deliver to society, e.g. carbon credits or biodiversity (management agreements)

- Encourage wide-spread voluntary practices (grass-roots mechanisms)
- Establish mechanisms for effective knowledge dissemination and exchange.

Discussion

Mechanisms for knowledge dissemination:

- Sebastien Janssens (policy maker, M): To establish mechanisms for the dissemination of knowledge and information exchange with regard to soil and nutrient management, a project has recently started in Flanders on behalf of the Flemish Land Agency (VLM): “Information and guidance services for optimizing nutrient management” (B3W). This project is a collaboration of 14 different partners, including research and practice centres, research stations and other advisory centres.

Policy analysis and coherence of policy:

- Gert Van de Ven (advisor, M): the SoilCare results regarding policy should be coordinated with another European project FABulous Farmers, in which a policy analysis is also made (https://www.fabulousfarmers.eu/nl).

Policy regarding wood chips and manure legislation:

- Gert Van de Ven (advisor, M): How will the results of the wood chips be translated into policy? Carbon build-up and nitrate residues do not always match together.
  Annemie: policy people from both topics are present here. Policy makers are also invited to this theme at European level. The policy brief drawn up here can also be sent to the relevant stakeholders in Flanders.

- Sebastien Janssens (policy maker, M): there is a lot of talk about carbon that is strongly linked to nitrogen. Both cannot be separated from each other. One should not only focus on carbon, but also always take nitrogen and other greenhouse gases (N_2O) into account. Does it make sense to continue to invest energy in such trials if we know in advance that the results will not be visible in the short term? Try to take a broader view.
- Gert Van de Ven (advisor, M): These things have to converge at the farm level. The (manure) legislation changes every 4 years. This makes it difficult for farmers to work on this for the long term.
- Sebastien Janssen (policy maker, M): Working on soil quality is always a win-win. Cover crops are also strongly encouraged by legislation in Flanders.
- Annemie Elsen (researcher, F): More focus should be placed on stimulating rather than punishing policy.

Policy regarding the use of residual biomass flows (wood chips) in agriculture:

- Annemie Elsen (researcher, F): Wood chips are already being used by some farmers to improve spots with bad structure (e.g. wet spots) in fields (although in principle this is not allowed just like that).
- Kathleen Van den Eynde (policy maker, F): The report with an overview of the results with wood chips that was provided to us by the Soil Service of Belgium, including the results of the scientific SoilCare experiment, is a solid basis for adjusting the legislation on wood chips.
- Katleen Van den Eynde (policy maker, F): Questions from farmers about the risk of wood chip contamination are uncommon. For the time being, we are not experiencing many negative effects on soil quality. What is important is that enough wood chips must remain available to make compost. The authorization we are aiming for will mainly concern wood chips from landscape management, and not so much the use of wood chips from intercommunal waste companies.
- Jan Van der Velpen (farmer, M): Is there a difference between accredited processors and recycling parks for the licensing of certain biomass waste flows?
- Katleen Van den Eynde (policy maker, F): yes, possibly.

At the general request of the various stakeholders participating in the workshop (policy makers as well as advisers and farmers), the policy brief drawn up for Flanders will be forwarded to them.

Impacts

Impacts that have happened

Wood chips:

- Knowledge spreading: articles, presentations, webinars
- Demonstration and guidance projects, in collaboration with several other partners; some examples:
  - The project “Landbouwers-koolstofbouwers” (Farmers – Carbon farmers) was started in 2019 in collaboration with Regionaal Landschap Zuid-Hageland (stakeholder Egbert Asselman). The objective is, in close collaboration with nine

municipalities, to widely roll out to practice a number of agricultural measures that have proven effective in terms of soil quality and carbon storage in the soil. The participating farmers are individually guided towards the implementation of measures. The municipalities are taking the initiative to enter into a long-term partnership with these farmers, whereby measures in the public domain are aligned with the farm measures and will continue to work after the project.

- The project "Koolstofboeren" (Carbon Farmers) was started in 2020 in collaboration with Boerennatuur (stakeholder Leen Vervoort) and aims to encourage and support farmers to integrate carbon storage as an important part of their business operations, including the development of a result-oriented compensation system that compensates farmers for the providing the ecosystem service of carbon storage. This involves bringing together the knowledge, expertise and networks of various relevant partners and projects into carbon business action plans in consultation with relevant farms from various regions and sectors.
- The demonstration project "Circulaire koolstofopbouw voor een betere bodem" (Circular carbon build-up for better soil) was started in 2020 in collaboration with various partners (including stakeholders Mieke Vandermersch, Jasper Somers and Leen Vervoort), with the main objective of demonstrating the

  application of organic materials that improve soil quality, with specific attention to residual flows released within recycling systems: farmyard manure, compost, Miscanthus, wood chips.
- The project "Bierbeekse boeren doen aan circulaire koolstofopbouw" (Bierbeek farmers doing circular carbon sequestration) will be started in 2021 in the municipality of Bierbeek on the initiative of Jan Vandervelpen (SoilCare stakeholder). The objective is to reuse the woody material from the maintenance of hedges and hollow roads and from the collection of prunings on the agricultural fields within the municipality, in order to realize more robust soils that can withstand the challenge of climate change as well as to contribute to climate mitigation by sequestration carbon in the soil.

- Policy: OVAM (Public Flemish waste company) is working, based on a research report prepared by the Soil Service of Belgium, on an adaptation of the legislation concerning the use of wood chips as a soil amendment (OVAM Action Plan for food loss and biomass (residual) flows circular 2021-2025).

Striptill and grass undersowing:

- There is little interest in striptill because of the risks, the cost and the practical feasibility.
- There are opportunities and interest (from both farmers and policy) for grass undersowing. Further fine-tuning of the technique, as well as knowlegdge spreading and demonstration is provided in collaboration with Hooibeekhoeve (stakeholder Gert Van de Ven).

Future impacts: how can the application of soil improving cropping systems be further stimulated?

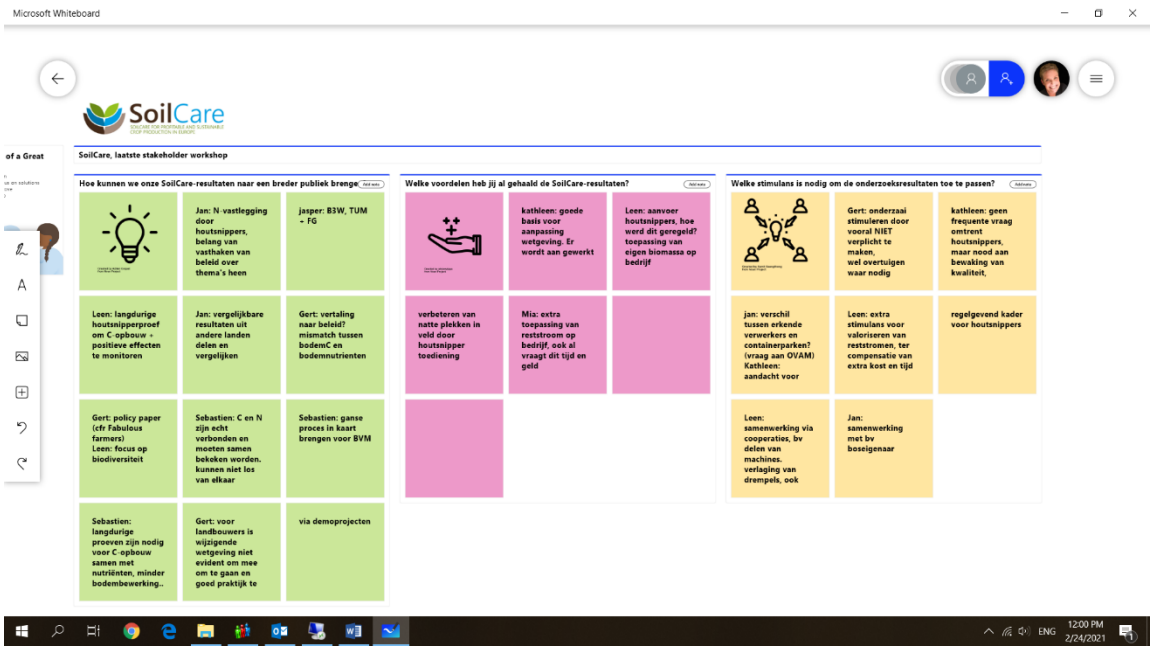
- Gert Van de Ven (advisor, M): Grass undersowing in maize: certainly not make this compulsory. In the Netherlands, this technique became mandatory, with the result that the number of farmers who wanted to apply this dropped. Interest of the farmers declined because of the mandatory nature. Grass undersowing should be viewed from the perspective of problems at the farm level and not imposed from above for an entire region.

Results of the take-home messages (postcard exercise)

The following take-home messages were received on the postcard (via email):

- Kathleen Van den Eynden (policy maker, F): include the results of SoilCare in the process of amending legislation.
- Martien Swerts (policy maker, F): Examine how wood chips can be included in policy.
- Sebastien Janssens (policy maker, M): Grass undersowing in maize ("average across all experiments") for nutrient management and soil care is doing better than sowing grass after maize.
- Davy Vandervelpen (advisor/farmer, M):
    - Application of wood chips: I liked the rapid effect on the infiltration rate. You may not be able to apply wood chips on a large scale, but if these resulting from the maintenance of wood edges and other existing natural elements should also be legally allowed to be used on arable fields, this is an interesting technique that can be applied on a smaller scale by many farmers.
    - Grass undersowing: not easy to apply in practice, but worth considering in practice, especially because of the contribution to organic matter. The effect on the nitrate residue does not manifest itself until later in the season (after 15/11).
- Jasper Somers (advisor, M): with what I learned today I want to continue to familiarize farmers and horticulturists with 'soil care'. Certainly, within the new guidance and information service B3W, the SoilCare results will add value.
- Leen Vervoort (advisor, F): The potential of the wood chip technique for agricultural soils has also been demonstrated with this project. The elimination of barriers is the next important step in their upscaling. The development of a generic legislative framework by OVAM for the use of wood chips from wood edges or forest management will be essential in this respect, as will be a stimulating financial instrument.
- Gert Van de Ven (advisor, M): Continue to work with compost as a source of organic material.
- Jan Van der Velpen (farmer, M): Organic carbon build-up is a long-term process. A reasoned application of soil amendments is necessary to avoid or limit the negative effects. It is striking that with the input of the wood chips compared to the other (more common) soil amendments, the C-build-up is clearly more efficient, although this also requires several applications spread over several years. I am interested in working with wood chips at our fruit growing company in addition to the annual pruning wood that is already traditionally incorporated in the tramlines with a chopper. The question still remains whether in practice we should rather focus on the replanting phase of the

orchard, where we can incorporate the old trees in full field on site (or first remove and process them in order to use them more judiciously). Or should we grind/chip and incorporate the wood chips more superficially and in smaller fractions into the tree strip (with more risk of vermin damage).



DENMARK

Report from SoilCare stakeholder-workshops in the Danish study site at Samsø

- Initiating workshop, 31 October 2018 at Samsø. By Chris Kjeldsen, Morten Graversgaard and Tommy Dalgaard. Followed up by a local meeting with farmers March 3, 2019.*
- Plant Congress (Plantekongres) session for farmers, Jan 15 2020. Presentation of results for the wider farmer community
- Feb 6, 2020 final workshop at Samsø. By Mette Vestergaard Odgaard and Niels Mark Jacobsen, with presentation and discussion of results from a focused group of farmers.

Including the following details:

- English and local language fact sheet with summary findings: In summary the main Soil Improving Cropping Systems interesting to the local farmers were Better Use of Catch Crops and Composting, in particular in relation to high value vegetable crops and early potatoes (see appendix for further info)
- Feedback on results (based on summary of questions and discussion after presentations)
- Feedback on validation and usefulness (based on post-it exercise, based on the IDEKU method: See appendix below)
- Suggestions and offers of help to further disseminate findings (based on post-it exercise: See appendix below)
- SoilCare impacts to date (based on post-it exercise: See appendix below)
- Plans/aspirations for future impact (based on final exercise: See appendix below)

In addition to these workshops an additional framing stakeholder workshop was held at Askov Research station at the start of the project, and a national stakeholder workshop meeting was arranged in Foulum 1. October 2018 (see Graversgaard et al. 2018).

Appendix:

Report from the soil carbon workshop at Samsø. In Danish:

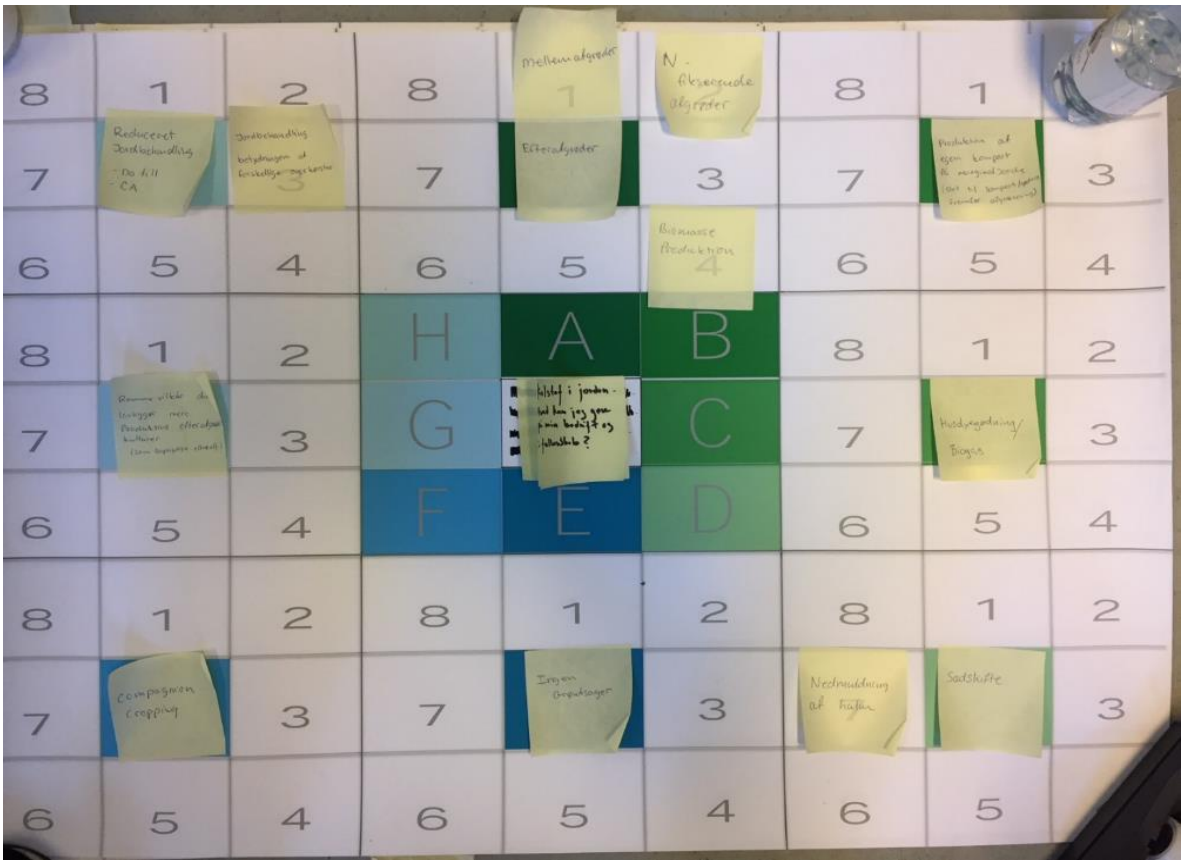
Kulstof i jorden – Hvad kan jeg gøre på min bedrift og i fælleskab?

By Morten Graversgaard, Chris Kjeldsen og Tommy Dalgaard, Institut for Agroøkologi, Aarhus Universitet.

På workshoppen var der først oplæg fra Tommy Dalgaard, Aarhus Uniersitet, og Knud Tybirk, Samsø Kommune.

Workshoppen sluttede med at deltagerne i grupper kom med ideer som svar på følgende spørgsmål: *Kulstof i jorden - Hvad kan jeg gøre på min bedrift og i fælleskab?*

Idegenereringen blev struktureret ved at bruge IDEKU metoden (Kollerup, F.), også anvendt ved workshoppen kulstoflagring i kvægbruget, afholdt på Foulum den 1. oktober 2018 (Graversgaard et al. 2018).



Der blev drøftet ved fire borde, hvor deltagerne kunne notere temaer og dernæst ideer på fortrykte skemaer og drøfte hvilke ideer, de ville give højest prioritet. Processen blev igangsat ved at deltagerne i hver gruppe, i stilhed skulle komme med 8 tema (placeres omkring hovedspørgsmålet i felterne A-H). Herefter skulle hver gruppe udspecificere de identificerede tema i konkrete retninger, ved at placere hvert tema som centrum i de omliggende kvadrater (med 8 felter til retning). På nedenstående billede kan ses et eksempel på det udfyldte skema fra en af grupperne. Ikke alle grupper nåede at diskutere 8 temaer.

På skemaet/tavlerne (billederne) skulle grupperne finde 8 ideer til spørgsmålet: kulstoflagring - Hvad kan jeg gøre på min bedrift og i fælleskab?
Disse idéer (med post-it sedler) skulle de placere på bogstaverne A-H. Herefter skulle de i fælleskab for hver ide, præcisere ideen gennem retninger (handlinger). Og placere disse handlinger (kaldet retninger) rundt om hver idé (A-H). Dvs. det er en måde at strukturere handling omkring en idé og dobbelt idé-genere.

Det lykkedes bedst for gruppe 2 og til dels gruppe 3. De skulle nok have haft mere tid. Men ideen med at de skulle summe hver enkelt først skete ikke, da de meget gerne ville diskutere imellem hinanden.

Så det var også lidt en test af en metode, som klart skal udvikles før den kan bruges igen.
Vi har afprøvet den til en anden workshop og her havde de mere tid.

I forhold til idéerne_:
Fx efterafgrøder blev præsenteret som idé i alle grupperne og her blev der præsenteret 6 retninger (handlinger) nogle mere specifikke end andre.
Kompostering gik også igen i alle grupperne, men også mange andre ideer (i alt 24 forskellige)… Det er da meget godt, hvor brugbare de er, er jo så næste skridt.

Figur 1: Udfyldt gruppeskema med ideer til kulstoflagring i jorden.

Der blev i alt generet 27 ideer med 46 retninger:
Gruppe 1 fandt frem til 8 ideer med 6 retninger.
Gruppe 2 fandt frem til 8 ideer med 18 retninger
Gruppe 3 fandt frem til 8 ideer med 15 retninger
Gruppe 4 fandt frem til 3 ideer med 7 retninger

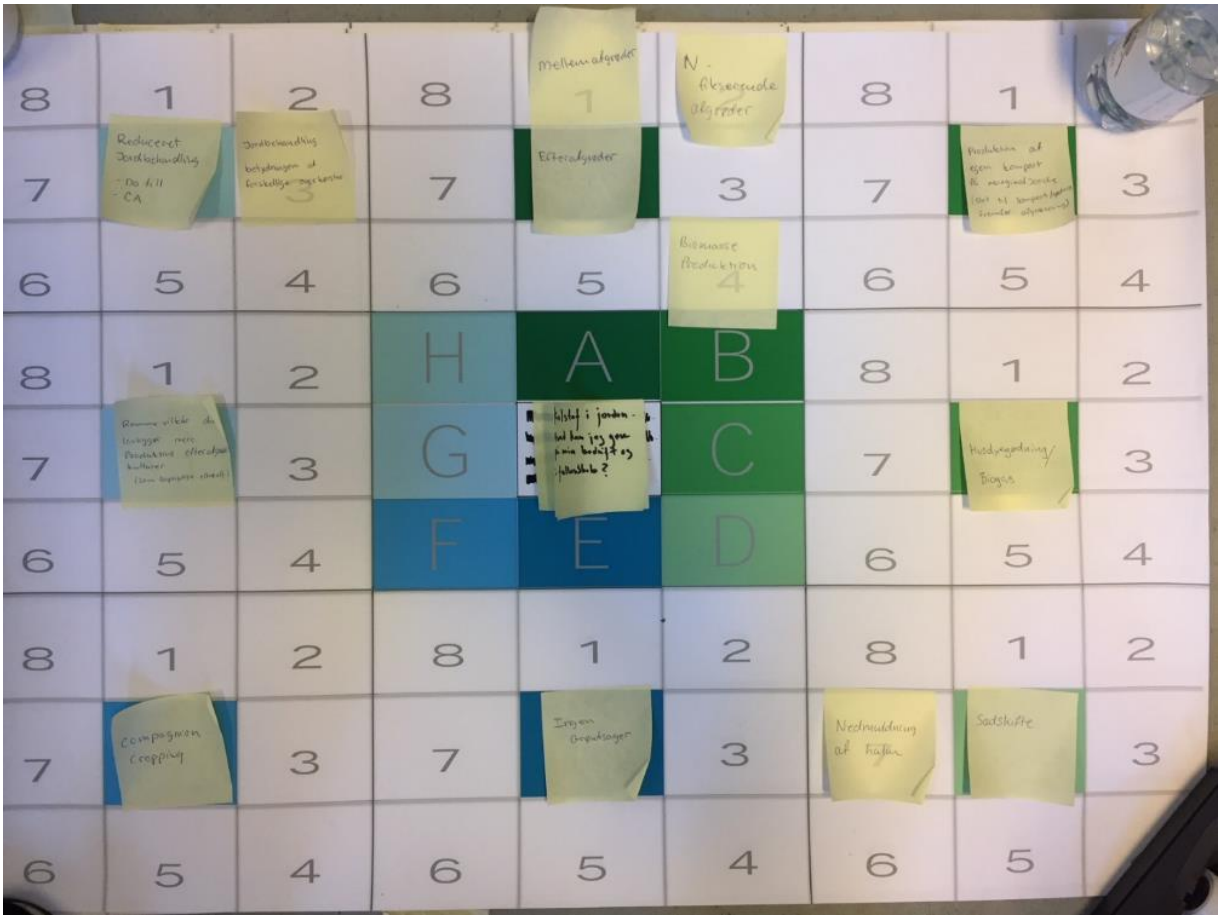
De 27 ideer blev efterfølgende samlet til 24 hovedideer (da der var nogle overlap). I nedenstående oversigt ses, hvor mange retninger, der kom på de forskellige hovedtemaer (angivet i parentes). Ved nogle ideer, blev der ikke diskuteret retning eller tiden var ikke til det.

1. Efterafgrøder (6)
2. Produktion af egen kompost på marginaljorde
3. Husdyrgødning/Biogas (1)
4. Sædskifte
5. Ingen grøntsager
6. Companion cropping
7. Ramme vilkår der lovliggør mere produktive efterafgrødekulturer (1)
8. Reduceret jordbehandling (2)
9. Mere frøgræs/kløver til høst (1)
10. Øget husdyr – Fælles besætning (3)
11. Plantning af skov (4)
12. Samdyrkning af afgrøder (4)
13. Afhøst af ”overjordisk” efterafgrøder (1)
14. Fælles kompost anlæg (1)
15. Flere afgrøder sået før høst (4)
16. Øget dyrkning af græs frø/ lucerne frø (3)
17. Holde op med at sælge halm (3)
18. Jordkvalitet / Generationsskifte / Værdiopbygning i jorden
19. Halmsnitning / Direkte såning / Efterafgrøder
20. Forskning i C-nedbrydning (hæmme bakterier der nedbryder C) (1)
21. Mere kompost (4)
22. Recirkulering af næringsstoffer fra byen
23. Optimal plantevækst (2)
24. Begræns/opbygning – Tabet af C (5)

Efterafgrøder blev præsenteret som ide i tre grupper og diskuteret i alle grupper.
Desuden blev kompostering diskuteret i tre af grupperne.

Nedenfor ses gruppernes ideer gengivet.

Gruppe 1:



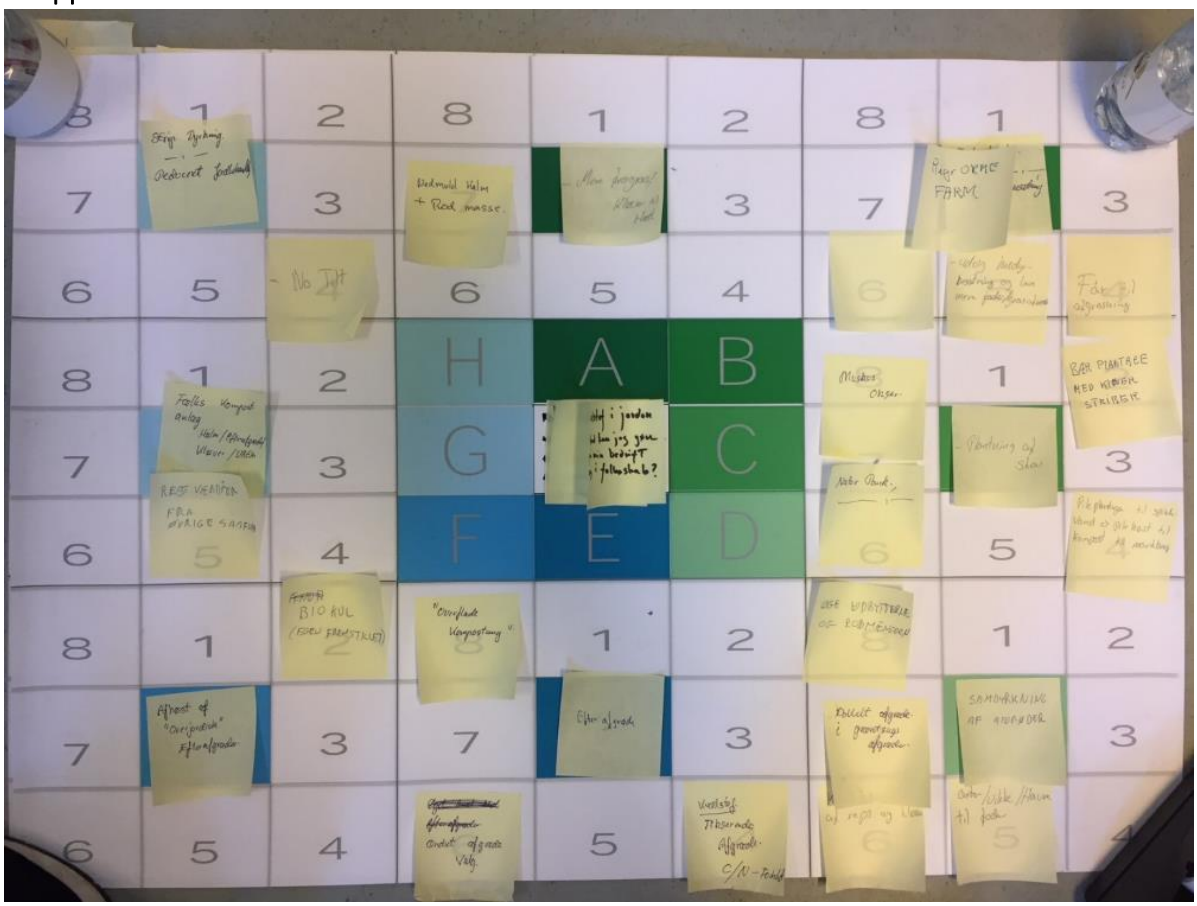
A) Efterafgrøder
- Mellemafgrøder
- N-fikserede afgrøder
- Biomasseproduktion

B) Produktion af egen kompost på marginaljorde (slet til kompost/gødning frem for afgræsning)
C) Husdyrgødning/Biogas
D) Sædskifte
- Nedmuldning af halm

E) Ingen grøntsager
F) Companion cropping
G) Ramme vilkår der lovliggør mere produktive efterafgrødekulturer
- som lovpligtige efterafgrøder

H) Reduceret jordbehandling
- no till
- Conservation Agriculture
    - Jordbehandling - betydningen af forskellige overkørsler

Gruppe 2:



A) Mere frøgræs/kløver til høst
- Nedmuld halm + Rod masse

B) Øget husdyr – Fælles besætning
- Får til afgræsning
- Udvid husdyr besætning og lave mere foder/græsafgrøder
- Regneorm farm

C) Plantning af skov
- Bærplantage med kløverstriber
- Pileplantage til spildevand -> pilehøst til kompost til markbrug
- Naturpark
- Moskus okser

D) Samdyrkning af afgrøder
- Ærter/vikke/havre til foder

- Kombination af raps og kløver
- Dobbeltafgrøde i grøntsags afgrøder
- Øge udbytterne og rodmængden

E) Efterafgrøde

- Kvælstof fikserede afgrøde C/N-forhold
- Ændret afgrøde valg
- "Overflade kompostering"

F) Afhøst af "overjordisk" efterafgrøder

- Bio kul (egen fremstillet)

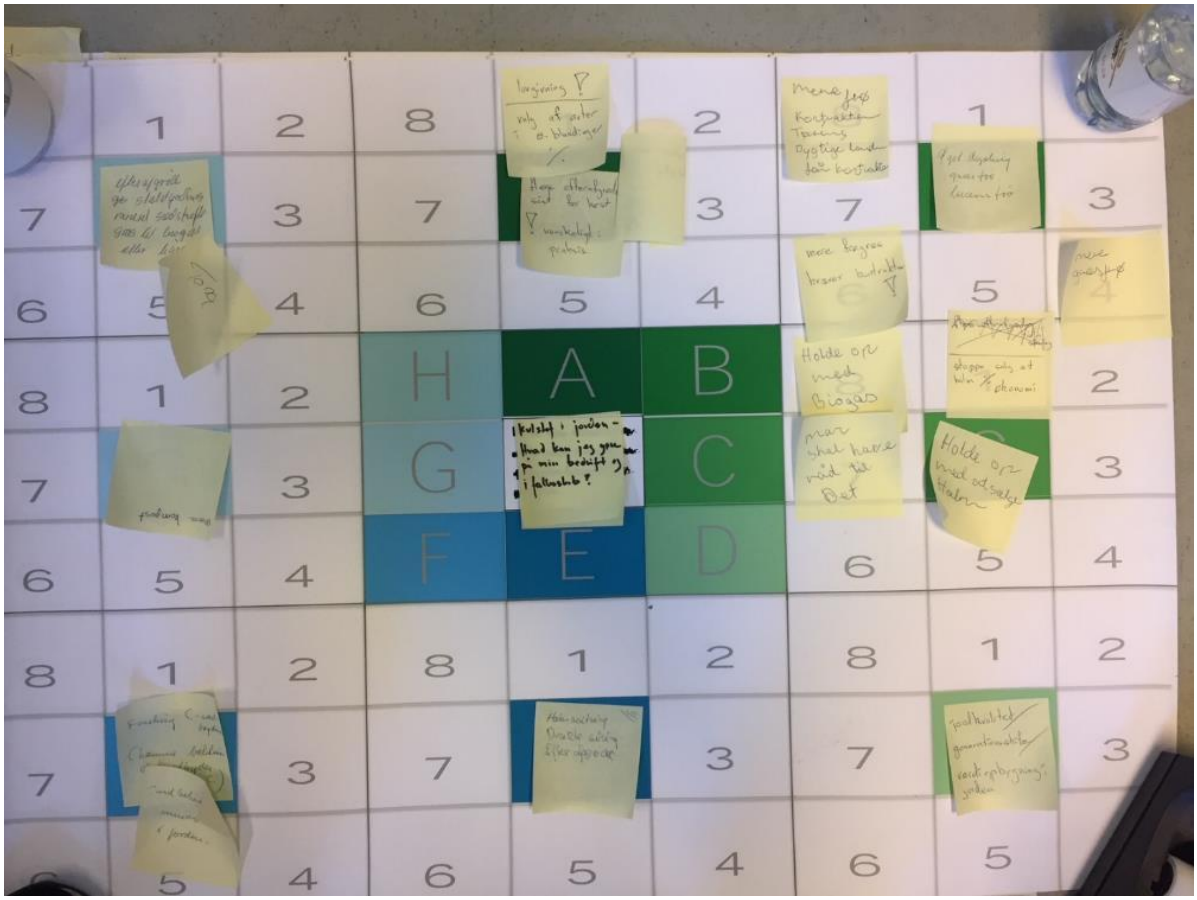
G) Fælles kompost anlæg -> Halm/Efterafgrøder/Kløver/UREA

- Rest værdier fra øvrige samfund

H) Stripdyrkning – Reduceret jordbehandling

- No till

Gruppe 3:



A) Flere afgrøder sået før høst

- Vanskelig i praksis!
- Lovgivning!
- Valg af arter i e-blandinger %
- Strukturarter som afgrødevalg

B) Øget dyrkning af græs frø/ lucerne frø

- Mere græs frø
- Mere frøgræs kræver kontrakter!
- Mere frøkontrakter. Tørring. Dygtige landmænd får kontrakter.

C) Holde op med at sælge halm

- % økonomi
- Man skal have råd til det
- Holde op med biogas

D) Jordkvalitet / Generationsskifte / Værdiopbygning i jorden

E) Halmsnitning / Direkte såning / Efterafgrøder

F) Forskning i C-nedbrydning (hæmme bakterier der nedbryder C)

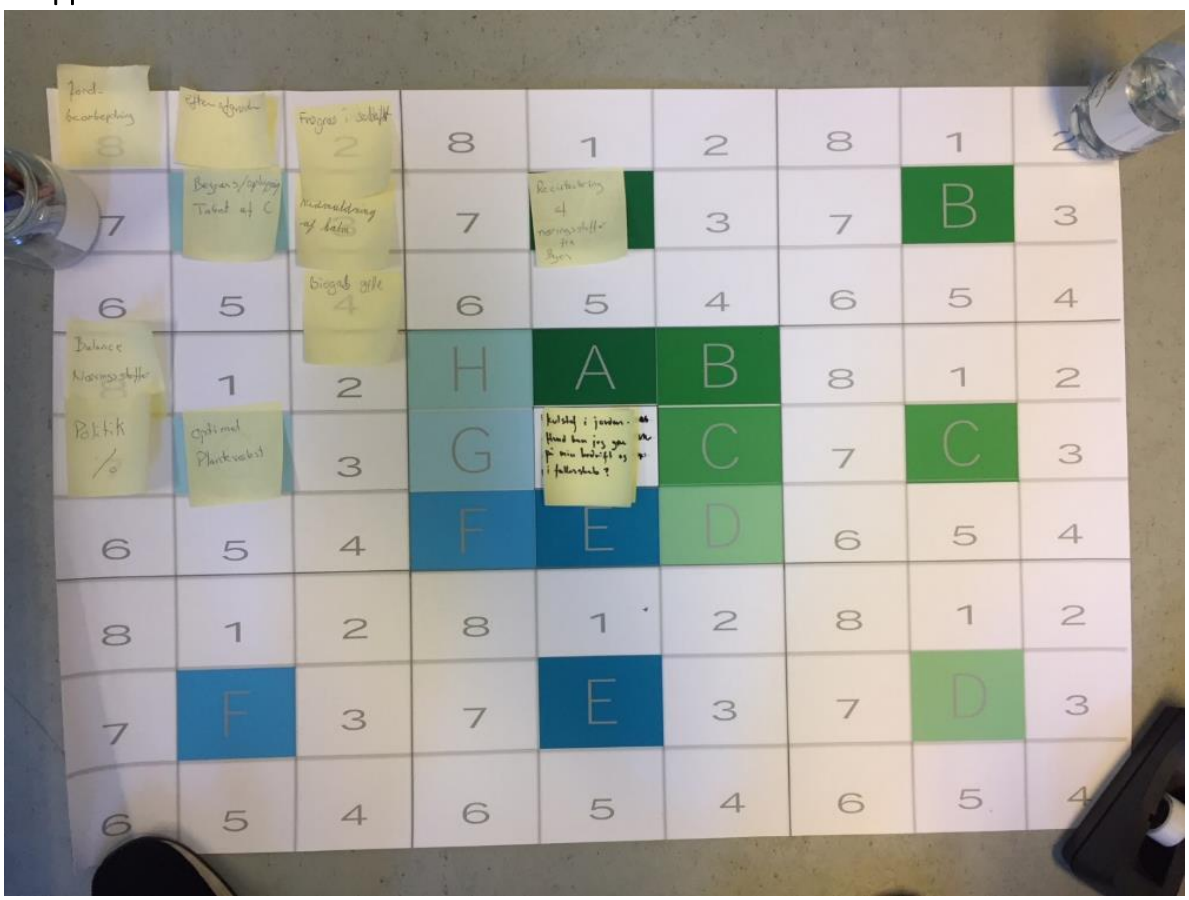
- Jordbehandling – mindre ilt i jorden

G) Mere kompost

H) Efterafgrøde

- staldgødning
- varieret sædskifte
- græs til biogas eller lignende
- Tona

Gruppe 4:



A) Recirkulering af næringsstoffer fra byen
G) Optimal plantevækst

- Balance næringsstoffer
- Politik %

H) Begræns/opbygning – Tabet af C

- Efterafgrøder
- Frøgræs i sædskiftet
- Nedmulding af halm
- Biogas gylle
- Jordbearbejdning

Photos from the workshop:

Referencer

Graversgaard M, Dalgaard T, Oudshoorn F og Fog E (2018). Hvad kan kvægbrugeren gøre for at reducere klimagas udledningen? Workshopnotat med oversigt over ideer og retninger genereret ved workshop omkring kulstoflagring i kvægbruget. Working Paper, Aarhus Universitet, Institut for Agroøkologi, Foulum. 21 s.

FRANCE

Final stakeholder workshop

3th February 2021

Introduction

The workshop reached two goals:

- the presentation of trial findings, and the collection of feedbacks among participants
- to provide an overview of the key achievements realized in 2020 by the stakeholder panel and to define actions to carry out for 2021

12 people participated to this final workshop (visioconference). The ratio between men and women was 2/3 women and 1/3 men. Whereas men are over in the decision-making bodies of the organizations which took part of the workshop (mainly association of farmers), the representation of women and men is quite equal across the employed teams.
The organisations and types of groups of participants are detailed in the table below.

Organisation, type of group	Number of participant(s)	Gender
Soil expert	1	Men
Researcher	2	Women
National organic food and farming institute	1	Women
Departmental council (Ille-et-Vilaine)	1	Women
Cooperatives for the use of agricultural equipment	1	Women
Association of organic or biodynamic farmers	4	2 men /2 women
FRAB	2	Men

Despite several reminders (mail invitations, phone calls), there were no participation from any policy-makers or regulating officers (Regional Council of Brittany, Regional Direction for Agriculture, Food and Forests).

Research findings

- Policy analysis: promoting SICS adoption in Brittany

Results from the policy analysis were presented to the audience. Seven policy recommendations were identified in the report. Participants were asked to vote for the most important recommendations according to them. This short survey provides the results below.

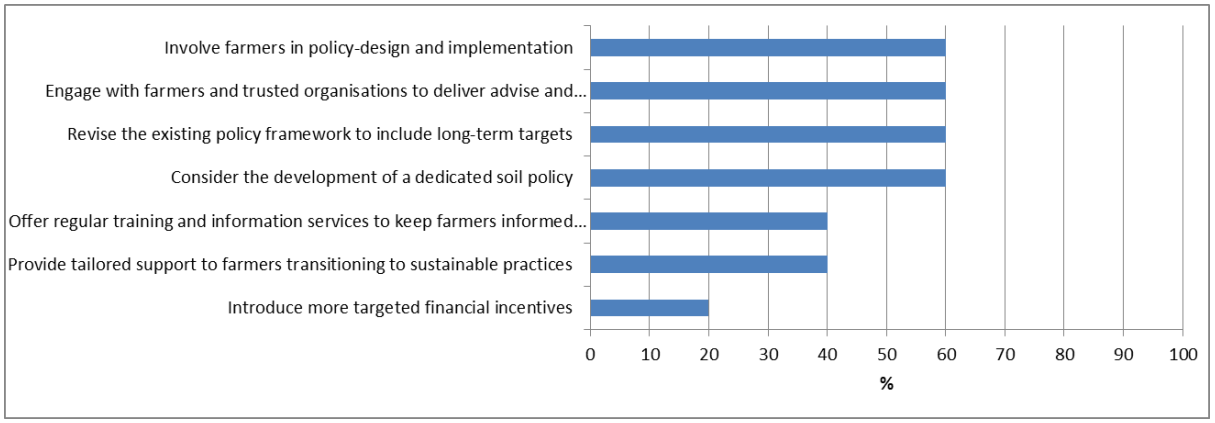


Figure 1. Prioritization of policy recommendations

There was no disagreement among stakeholders on the policy recommendations formulated by the policy analysis. One stakeholder (*technical adviser - departmental council, women*) brought a new recommendation: the test of new instrument or policy tools at a local or sub-regional scale first, to analyse their impact locally before a potential expansion at a more global scale (regional or national). There was a consensus across participants for this new recommendation.

- Early sowing of wheat

The aim of this trial was the early sowing of winter wheat, to advance soil preparation in the end of summer, to prevent winter soil erosion and nitrogen losses.
Main findings:

  - This technic is interesting to improve soil health for some soil parameters, although the results are not so discriminating as we expected (aggregate stability, microbial biomass).
  - It is difficult to implement this SICS due to high dependence of climatic conditions
  - It was not possible to harvest wheat at the end of each trial due to high weed infestation and lake of wheat development.

- Seeding of a cover crop in maize (on the row)

The aim of this trial was the sowing of a cover plant (buckwheat) on the cultivated rows (maize) to limit weeds development, to reduce the number of mechanical weeding interventions and limit soil compaction.
Main findings:

  - Buckwheat was too much competitive and yield reduction occurred when associated with maize.
  - There were no significant differences found between treatments on soil parameters aside from Kstat (infiltration capacity), which was higher in maize-

buckwheat plots. However, the short duration of this study means that significant differences were unlikely due to the time required to observe significant changes in soil health.

- Cover crops

The aim of this experiment was to evaluate the impact on soil of a complex cover-crop compared to a mono-specific cover-crop. Our hypothesis was a better nitrogen capture and less weeds development with the complex cover-crop.

Main findings:

- When emergence rates are satisfying, several soil parameters (aggregate stability, infiltration capacity, nitrogen capture) benefit from complex cover crop.
- But there was no effect on rooting depth and total biomass.

- Maize direct sowing

The aim of this trial was the testing of a direct sowing of maize in a faba bean-pea cover, using a front-roller (rolofaca) and a direct seed drill.

Main findings:

- This trial failed because it was not possible to establish the faba bean-pea cover during the fall because of high levels of rainfall. As there were too much weeds in the faba bean-pea cover it was not possible to consider a direct sowing of maize.
- The success of this practice seems very uncertain in Brittany, and would not be resilient to face climatic hazards.

<u>Discussion of research findings:</u>

After the presentation different discussion points were talked:

-

- In general, there were too many soil parameters. It would be preferable to target two or three soil parameters depending on each trial objectives. The relevance of several indicators was pointed out (aggregate stability, infiltration capacity, bulk density…) by the experts. There is an inadequacy between our focus testing and a very complete monitoring plan. Such monitoring plan would be most suitable for long term experimentation.
  ⇨*Soil experts point of view (advisers – mainly men)*
  ⇨*As the discussion was technical only half of the participants provided their opinion on this subject. There was a consensus among soil experts-advisers.*
- Some measures should be completed by others. For example: aggregate stability should be completed by the monitoring of porous ceramic cups or by the analysis of water at the end of agricultural weeping tiles.
  ⇨*Soil experts point of view (advisers – mainly men)*

⇨*As the discussion was technical only half of the participants provided their opinion on this subject. There was a consensus among soil experts-advisers.*

- On the graph below (figure 3), we can observe a higher value in nitrogen in the classic sowing modality than in the early sowing of wheat. This can be explained by the resowing of a spring cereal on both sites (control) which involved tilling operations.
  ⇨ *There is a consensus among participants to conclude that these tilling operations enhanced mineralization processes. Several participants underlined that it is important to separate tilling operation and sowing by one month at least to favour aggregate stability.*
  ⇨ *"Rather than advancing the sowing of wheat it would be interesting to advance tilling operations only" (soil expert – man, 55 years)*

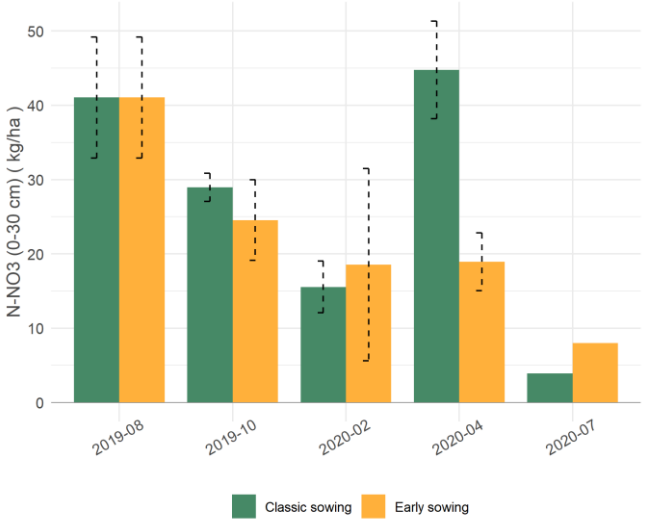


Figure 2. Nitrogen dynamic on the early sowing wheat experiment

- It is important to consider the context in which these results were obtained (soil type, practices, crop rotation, plot background…).
  ⇨*Agreement among all the participants on this point.*

- The survey showed that it would be preferable to had long term targets. There a discrepancy on our lake of capacity to lead long term experimentation and this recommendation.
  ⇨*Agreement among all the participants on this point*

Are these results in line with your understanding?	Percentage of "yes"	Comments
Early sowing of wheat	80%	This trial is interesting but could be simplified (shift of tilling operations only, testing structural stability in the field).

Seeding of a cover crop in maize (on the row)	100%	No surprises. This trial could be continued using a less competitive plant (dwarf clover for example).
Cover crops	50%	It lacks some measurements to conclude (cover crop biomass).
Maize direct sowing	100%	No surprises. The difficulties encountered are confirmed by the stakeholders.

Impacts that have happened

- The experiments were answering to farmer's concerns. But the experimental design was not really adapted. Most of the results are in line with the understandings of stakeholders but should be complemented by other indicators.
- This work provides a good basis to foster discussions among farmers, especially in peer-to-peer learning groups. The constitution and guidance of these groups is supported in France by different instruments ("30 000 groups" for example). These examples of successful voluntary initiatives are considered very effective in changing convictions and practices.
- The policy analysis is a good tool to step back and shape new instruments. The stakeholders underlined the need to continue the monitoring task on soil policy (regulation, incentive, financial). This would help in the introduction of more targeted financial incentives in particular.
- Because of weather conditions some trials failed or were not harvested (early sowing wheat, maize direct sowing). Although soil parameters provide interesting results, it is frustrating for farmers to not obtain a clear economic result on SICS. However, the trials showed the uncertainty of these practices in Brittany which is very informative.
- The SoilCare project permit the settlement of a dedicated soil area on the organic trade fair organized by FRAB every two years. Materials for this area are discussed and set up in a partnership-based approach. The objective is to provide key information to a better understanding of soil processes and encourage the visitor to make its own conclusions.

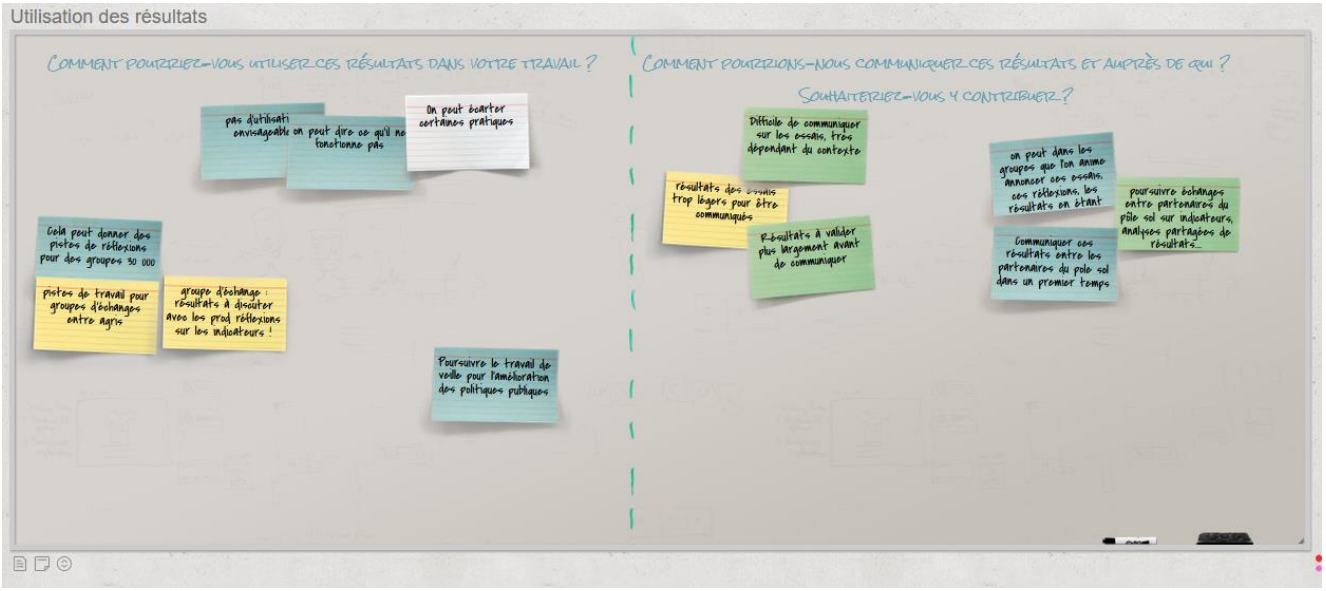


Figure 3. Screen capture of the "impacts" exercise

Future impacts

- After several years, the stakeholder panel is still dynamic and although the national organic trade fair was cancelled in 2020, all stakeholders reaffirmed their commitment to meet after the end of the SoilCare project (august 2021). The stakeholder panel is unique in Brittany and involved scientists, farmers, decision-makers, associations. Its role it is to emphasise different approaches on soil (tilling, soil conservation, biodiversity, erosion, fertilization…). There was a consensus among stakeholders to pursue and diversified dissemination activities (short videos, on farm soil days ⇨ see below).
- It is important to share results among stakeholders. If one practise has been tested (successfully or not) by one stakeholder, it would not be necessary for one other stakeholder to test it. It is interesting to keep this complementarity in the trials between stakeholders and this steering committee allows it.
- There are not so much opportunities to gather together researchers, decision-makers and farmers. However, it is important to keep this link between these professions. FRAB is a good medium. To foster these interactions between them the settlement of two actions was decided:
    - The establishment of a "Soil week" in the spring 2021 (22-26 march) : 4 events with the same pattern (one soil pit, 2 different workshops animated by 2 different stakeholders) in 4 different departments were discussed and planned
    - The realization of some short videos focusing on innovative soil cultivation tools was discussed and planned (depending upon available budget)
- It is important to keep in mind that we need to respond to farmer's needs because they have a direct impact on soil health by their agricultural practises.
- A partnership work was initiated with Brittany surrounding department (Loire-Atlantique) in the framework of the SoilCare project. This partnership could be extended to all this surrounding region (Pays de la Loire).

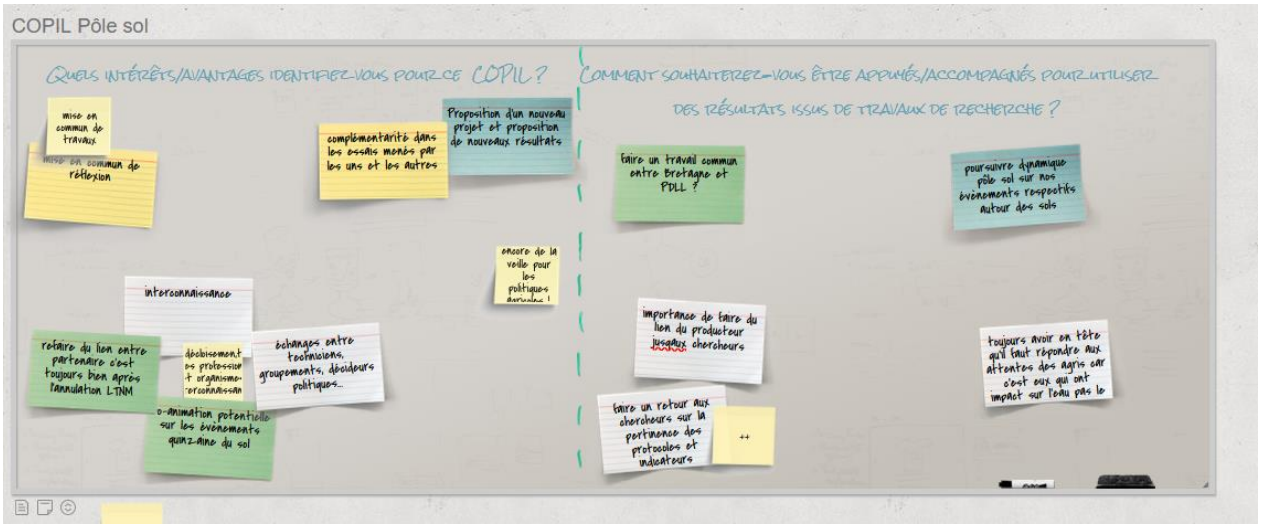


Figure 4. Screen capture of the "future impacts" exercise

Figure 5. Picture of one on-farm soil day at Campbon in the Loire-Atlantique department (26th march 2021)

Appendix

- Two final fact sheets used in the workshop
- A PDF of PowerPoint slides presented during the workshop

GERMANY

Final stakeholder workshop

Paula Mayer-Gruner

1. Introduction

The final stakeholder workshop was held to present the findings of the German study site and to talk about future types of assessment on conservation agriculture. It was, due to the pandemic situation, held as an online workshop at the 15th of February 2021.

The number of participants was 25 (see figure 1), among them were 8 females and 17 males. Represented groups were farmers, extension service, industry, agricultural administration, agricultural research, scientists. No policy maker accepted the invitation.

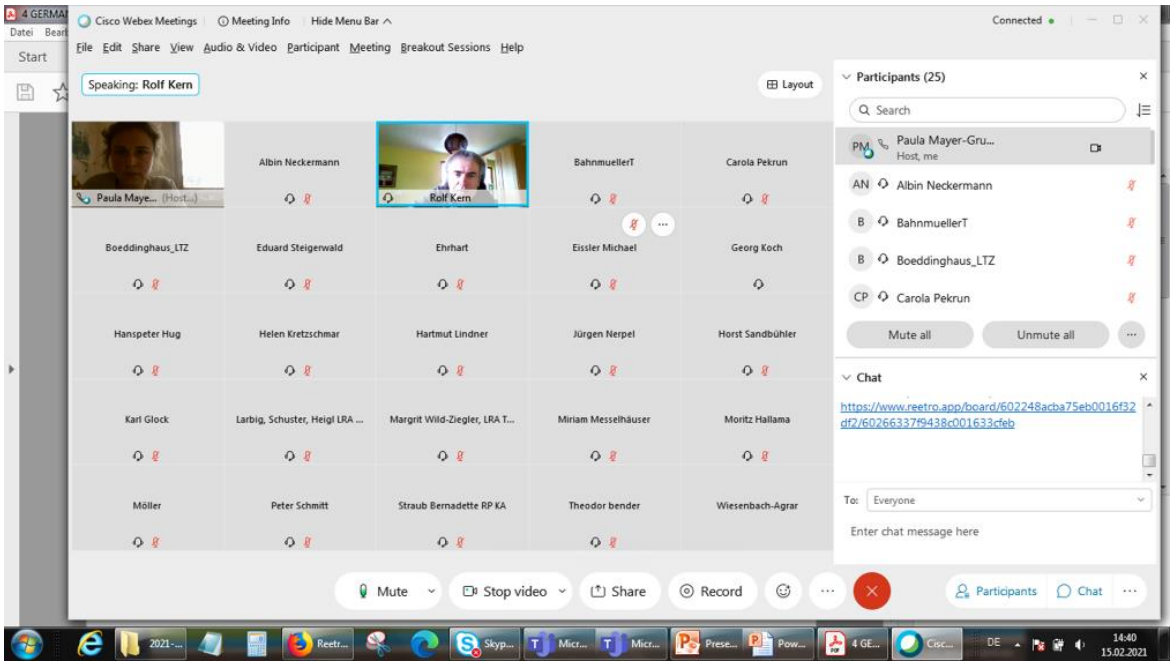


Figure 1: Screenshot of the participants of the last stakeholder meeting at the 15th of February 2021.

2. Research findings

At the experimental site in Tachenhausen, Germany, cover crop mixtures interacting with glyphosate followed by two main crops under reduced tillage were grown to counteract damage to soil microorganisms. In our field experiment, yield and quality of the main crops

were not significantly affected by intercropping and glyphosate avoidance. Earthworms and microorganisms directly benefited from the increased food supply of the cover crops. Glyphosate had a small short-term effect on microorganisms *(see fact sheets)*. Expert interviews revealed that flowering intercrops increase the reputation of agriculture in society, while glyphosate, which is essentially used in reduced tillage with cover crops, is under highest debate. The establishment of cover crops involves additional labour and costs. The economic aspect, together with the challenge of extended crop rotations and possibly higher weed pressure, is the biggest obstacle to the widespread use of catch crops without glyphosate. Therefore, financial support as well as knowledge and experience exchange among farmers on regional model farms would have a positive effect on cultivation (*see policy summary*). Sharing knowledge through materials such as the *booklet "10 mistakes…"* showing at one hand why cover cropping makes sense and the *interactive applicability maps*, demonstrating at the other hand where cover cropping is possible and necessary, can help policy makers to design more coherent policies and effective enforcement mechanisms.

3. Discussion of research findings

During the presentation of the project findings and afterwards, people had the chance to ask questions or to give comments at the chat.

Additionally, and as substitute to the post-it exercise, the participants had the chance to use the online platform *retro.io*. It helped to vote online if, to their opinion, the results were plausible, predominantly plausible, less plausible or not plausible. Also it is a tool to collect answers to plausibility and usefulness (see figure 2). Not all participants were familiar with the use of online tools in online meetings.

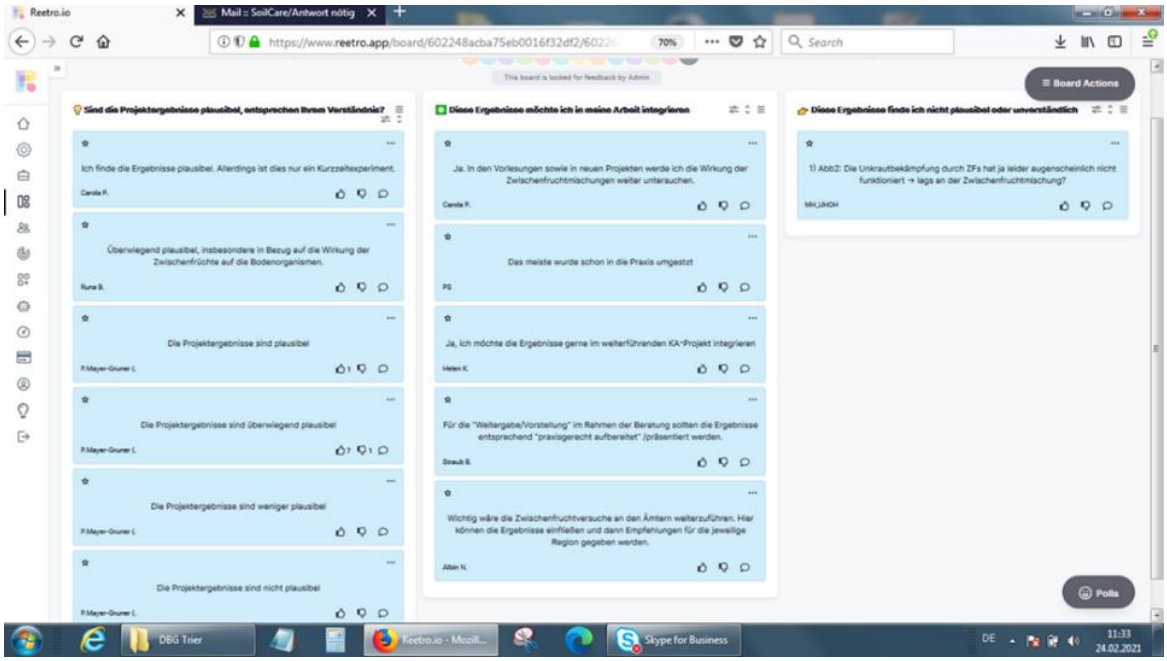


Figure 2: The online platform reetro.io. Screenshot with feedback to experiment fact sheets.

3.1 Discussion of the field Experiment

The people who took part at the voting thought that the findings of the field experiment as they are presented on the fact sheets (Appendix II) are predominantly in line with their understanding.

However, some points of the results remained unclear and were part of the discussion:

- Cover crops have the potential to supress weeds. But in this experiment, weed infestation after cover crops was higher than without cover crops- independent if glyphosate was applied or not. A scientist (m) asked if this means a failure of the cover crops and if another mixture of CC could be more successful. A representative of extension service (m) answered that he had good experiences with a mixture like this, containing different plant species. However, as the yield of the main crop was not affected, neither in quantity nor in quality, the weed cover was high but not harmful.

  -> Another farmer (m) reported that this might change over years with this system without glyphosate.

  -> Another scientist (f) thought that cover crops do indeed supress weeds that are harmful. If cover crops emerge in the next crop, they are better to handle than

harmful weeds. Additionally, if the yield is not affected by emerging cover crops in the main crops, the accompanying higher soil cover will even have positive effects on erosion.

- The experiment itself was not designed as to see how earthworms react to intensified tillage, it should be clarified where the information in the conclusion was from (scientist (f)).
- Conclusions are broad but should be viewed regionally, as e.g. regional climate might be a limiting factor of cover cropping (extension service (m)).

The discussion also revealed some limits of the experiment itself and pointed out that short-term-experiments are good to understand fast reacting mechanisms of soil organisms, but don't get information for a special land use management. For farmers, earthworms and other soil organisms do not play an important role for decisions. The main reason to plant cover crops would be to cope with erosion and nitrate pollution.

-> Long-term studies/experiences of changing land use management are needed to get reliable arguments for soil saving cropping systems.

It was not clear to the audience who should be the target group of the fact sheets. The opinion of extension service was that the fact sheets cannot be used by extension service as a base for recommendations, because one single experimental setup is not a reliable basis.

-> (Fact sheets for) recommendations should rely on a broad literature review of different (long-term) experiments (extension service (m)).

A great use of the fact sheet, such as it is, is to show the state of the research and to discuss and find further research topics. In this case, representatives from farmers, administration, science, and the extension service agreed that further research is needed on conservation agriculture without glyphosate. They could go in the following directions: underseeding, mulching, shallow plowing, and regional differences and requirements for technology, materials, extended crop rotation.

3.2 Discussion of the policy summary

The people who took part at the voting thought that the findings of the policy summary are predominantly in line with their understanding.

Spoken and written feedback can be summarised as following:

- The results are very interesting, but the implementation seems to be difficult (scientist (f)).
- Short-term monetary conversion assistance contradicts the slow-term planning capability that farmers need. Support programs should be designed for the long term (and not just as start-up aid) to give farmers planning security (agricultural research (f)).
- Cover cropping in Baden-Württemberg is mandatory in nitrate areas, so we no longer have to think about how you put into practice the introduction / maintenance of intercropping (administration (f)).
- Farmer, consultants and scientist could agree. But if decision-makers (politicians) don't want to listen to them, nothing will happen (farmer (m)).
- Elaborate more on the trade-off between glyphosate ban and conservation agriculture (farmer (m), scientist (f)).

3.3 Discussion of the booklet

The people who took part at the voting thought that the findings of the booklet are predominantly in line with their understanding. The contents are good and belong (already) to every agricultural education.

- In the case of soil activators, research institutes are called upon to critically examine them and monitor their development. Much more research would need to be done and made known among advisors and farmers.

Participants felt a huge discomfort for the target group described (farmers) in combination with the given information. The content is good and should be basic knowledge for every farmer in Germany. “The level of farmers that is assumed is frighteningly low. Target group must be

clearly named to prevent misunderstandings among the general public (agricultural administration, m)"

As it is, the booklet could be used well for the following audiences, this should definitely be specified in the booklet:

- "Could be used in the first year of vocational training" (administration, f)
- "Part-time technical students" (extension service, m)
- "Target group could rather be politicians who decide about agricultural issues "(farmer, m)
- "Be careful not to ruin reputation of farmer – content dedicated only to farmer is critical with regard to current political and ideological situation" (administration, m)
- - > could include different levels of knowledge to broader the target group (agricultural research, m)

Another point mentioned that the booklet may not be suitable for extension services in Germany, as their "working mode" in communication is different. Opinions of extension service (m), administration (f), scientist (f), farmer (m) are:

- "Not only show errors but motivate via positive speech, in order of what benefits do farmers get from a healthy soil."
- "Not lecturing but arousing interest and thinking positively of the farmers."
- "Do not name points as errors but should be formulated positively as points that are already respected or that need to be (further) considered"

Overall, participants agreed that this booklet may be interesting for people with little experience with soils. The audience should be absolutely precised in the prologue of the booklet to avoid misunderstandings and a bad reputation of experienced farmers.

3.4 Discussion of the applicability layers

Time went fast and we talked about the fact sheets and the policy report so that there was not much time left for the maps. The applicability layers were discussed in detail at the previous stakeholder meeting and improvement was done according to that.

Impacts that have already happened

The SoilCare project has helped tremendously in connecting various stakeholders and raising awareness of soil-improving cropping systems.

- Exchange with policy makers and adaptation of FAKT measures for better soil protection (science, agricultural administration).
- The use of cover crops and reduced tillage is well regulated in Baden-Württemberg.
- Information and interesting discussions during stakeholder meetings, raising the awareness of barriers of adoption of soil improving cropping systems (farmer, administration, extension service)
- Productive discussions and exchange of ideas on future actions in research and practical issues during stakeholder meetings and field days (farmer, science, administration)

Future impacts

The project findings are useful for teaching, lectures, talks among scientists and with students. The administration could forward the booklet to vocational schools to raise the awareness of soil health. For extension service, it is pointed out that field days on demonstration farms play an important role for spreading research findings among farmers. Field days are carried out as soon as the pandemic situation permits.

Applicability layers can be used in various ways for science, agricultural administration and policy makers and to support the findings of the policy summary.

4. Conclusion

The last stakeholder meeting revealed that soil health is a big issue for the agriculture in Europe. People interested in the SoilCare project are aware of it. Yet they feel that farmers don't have the capacity to take care of the soil because they are under pressure to meet a lot of different regulations (fertilization, plant protection, nature conservation, market economy, etc). This becomes obvious with the ban of glyphosate. It provokes more intensive tillage and undermines the progress that was achieved by direct seeding systems, dependent on glyphosate, to protect soil from erosion. As a result, further research is urgently needed for soil conservation agriculture after the ban of glyphosate.

For the implementation of cover crops, Baden-Württemberg acts as a pioneer. Other regions and countries could take an example from this.

The benefit of soil activators is still under debate and should be investigated further.

The target group of the final documents should be expressed more precisely in the editorial.

The implementation of the good practices for soil are not only important to farmers but should be anchored in society. These information can be spread with the booklet "10 mistakes…" to hobby gardeners and hobby farmers as well as to everyone who has to do with soils in one or the other way, like politicians, nature conservation clubs etc.

To achieve this it is important, to:

- Change the editorial of the booklet to specify the target audience.
- As a supplement to the online meeting, email to people who told to share project results and ask them if they need further information, documents or help.
- Spread the booklet in different platforms (social media).
- Reach policy makers

Appendix

Appendix I (a-d): Screenshots of the written feedbacks – "validation" and "usefulness" - to different research findings that were presented at the stakeholder meeting.

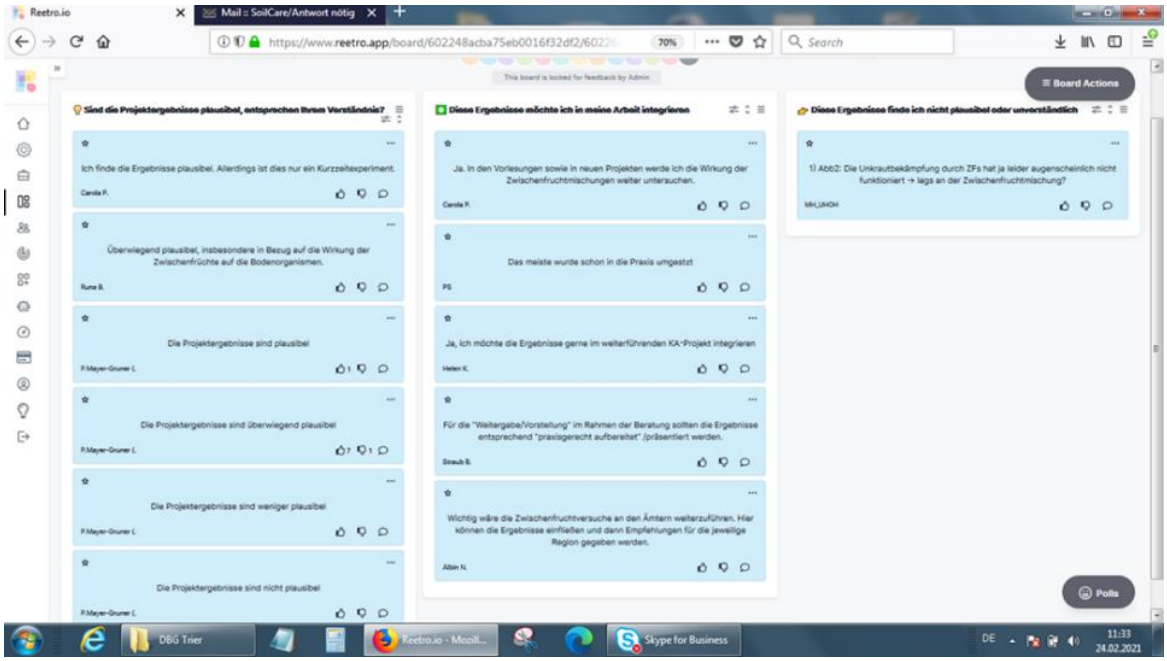


Figure I a: Written feedback to the experiment fact sheets.

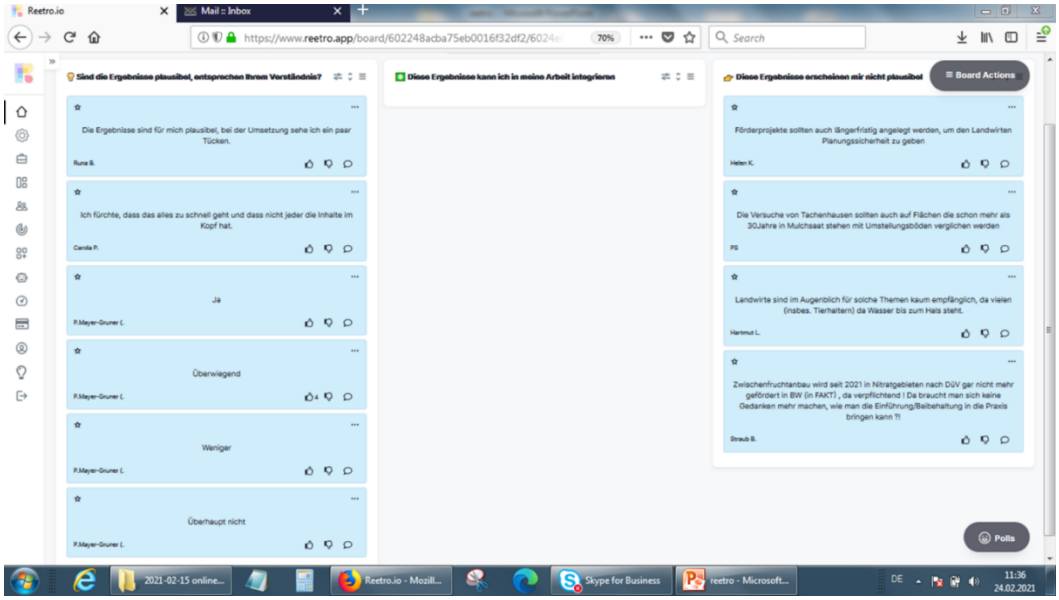


Figure I b: Written feedback to the policy summary.

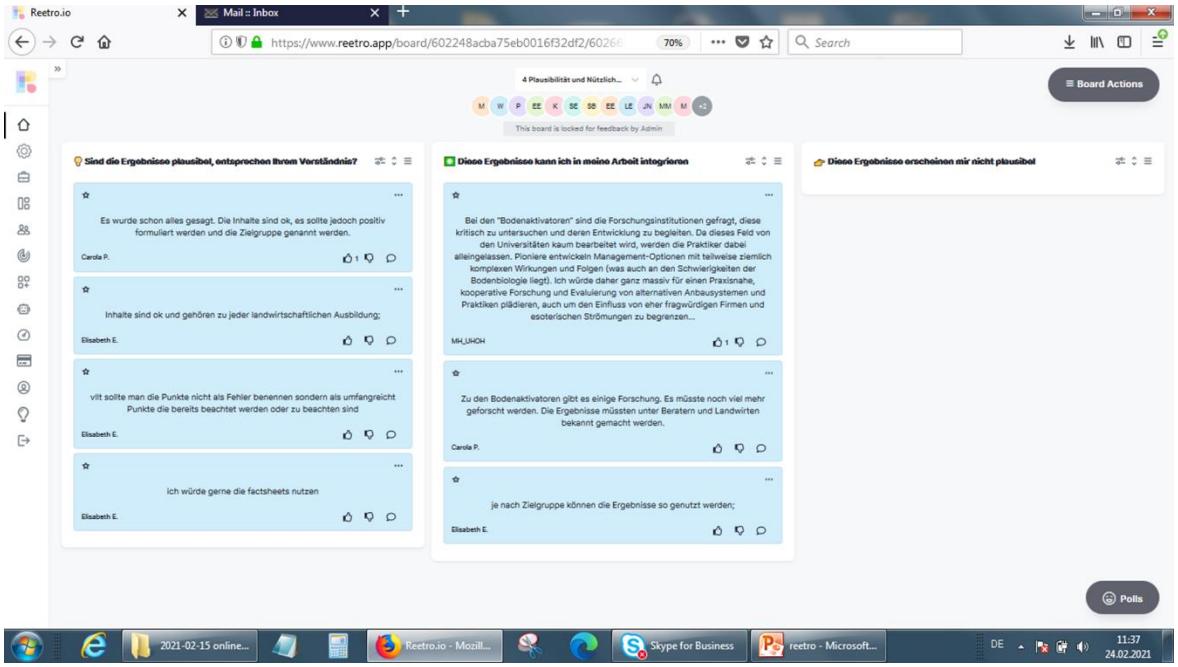


Figure I c: Written feedback to the booklet “10 mistakes...”

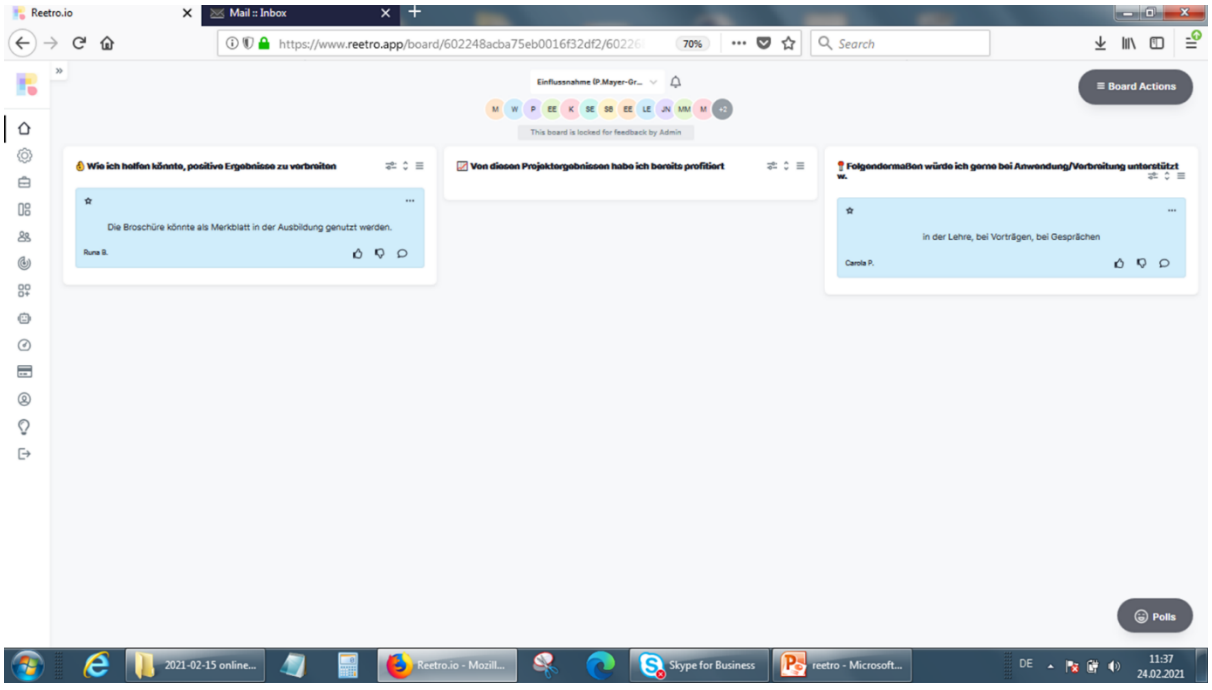


Figure I d: More written feedback to the booklet “10 mistakes...”

Appendix II: Final fact sheets used in the workshop (German) and in English

Appendix III: PDF of PowerPoint slides that were presented at the meeting as a handout with 6 slides per page

GREECE

Workshop Report - English summary

Final Stakeholder workshop

"SoilCare for profitable and sustainable crop production in Europe"

Results and conclusions from the final stakeholder workshop

Name of the study site: Chania, Crete, Greece

Main threat at the study site: Soil erosion

Author(s): Tsanis I.K., Seiradakis K., Sarchani S., Koutroulis A.G.

I. INTRODUCTION

A. Purpose of the workshop

The risk of erosion is particularly high in Mediterranean areas, especially in areas that are subject to inappropriate agricultural management, land abandonment or wildfires. Crete represents Mediterranean soils under imminent threat of desertification, characterized by loss of vegetation, water erosion, and subsequently loss of soil. Several large scale studies have estimated average soil erosion in the island between 6 and 8 tn/ha/year but more localized investigations assess soil losses one order of magnitude higher (Panagos et al., 2014).

Olives are the most important crop grown on the island of Crete, covering 64% of the arable land and representing 86% of the tree plantations on the island. Despite the problem of phyloxera in the 1980s and the Common Agricultural Policy (CAP) to reduce the area of vineyards, viticulture remains one of the most important production activities of Crete. Olive orchards and vineyards in Crete often suffer from extreme soil erosion by water due to farm slope and recent intensification of tillage practices. Average erosion rates for orange groves on the island are estimated at 1 tn/ha/year, whereas below the average at 8 tn/ha/year but still above other cultivations. Moreover, in the Chania Prefecture of Crete, orange cultivation is a major crop, but due to severe market competition producer prices have significantly dropped leaving little or no profit. Recently, avocado plantations have been proposed as a sustainable alternative over orange groves, but soil erosion for avocados has not been measured.

During the first stakeholder workshop the majority of stakeholders were already aware of the negative impacts related to soil erosion. Some commonly accepted and applied mitigation practices were discussed for further evaluation and potential outspread to more farmers and land owners as a way to combat soil erosion. These practices included minimum or no tillage, the application of cover crops/green strips and others. However, according to stakeholders, major knowledge gaps still existed regarding erosion processes, in terms of the extent to which different cultivation practices within the same crop affected the rate of soil erosion, as well as the performance and quality of production. The main objective of the SoilCare experiments were to evaluate and estimate the effect of different management practices on the soil erosion rates for specific crop types. The experiment initiated in 2017 and was set up in control versus treatment (SICS, elementary) experimental design with no replicates. It included different sets of treatments (1 control vs 1 SICS) located in three different fields. The different set of experiment's treatments targeted different cultivations (Vineyards, Fruit orchards, Olive orchards) for which relevant management practices were tested.

The main aim of the final stakeholder workshop was to present the monitoring results and analysis from the study site experiments in order to offer tangible information to stakeholders and to discuss with the researchers. Moreover, a short introduction to the SoilCare concept brought things together for stakeholders to update and realize the full scope of the project

and relate with other soil threats in different regions. Each meeting started with this introductory presentation about SoilCare, followed by the main aim and results as summarized in the WP5 final report, including the project aim and a definition and examples of soil-improving cropping systems. Study site specific results were then presented (Appendix) to facilitate discussion on the major research findings, communication and upscaling of results.

B. Date and location of the Workshop(s)
Workshop venue: Online meetings.
Workshop date: Various dates during February and March 2021.
Workshop moderator(s): Sarchani S., Koutroulis A. G.

C. List of participants:

*Local or external participant

#	Name	Stakeholder category/ institution	Gender	Age	(L/E)*
1	C. D.	Farmer (Olive orchard)	f	35-44	L
2	A. D.	Farmer (Vineyards)	m	35-44	L
3	V. M.	Farmer (Fruit orchards)	m	55-64	L
4	I. N.	Farmer (Vineyards)	f	45-54	L
5	L. K.	Farmer (Olive orchard)	m	25-34	L
6	M. M.	Farmer (Orange orchard)	m	55-64	L
7	V. E.	Agronomist, Prefecture of Crete	m	45-54	L
8	K. V.	Consultant, retired geologist	m	>65	L
9	N. K.	Farmer (Vineyards)	f	25-34	L
10	P. T.	Farmer (Orange orchard)	f	35-44	L
11	G. P.	Agronomist	m	45-54	L
12	Dr. E. V.	Researcher / Technical University of Crete	f	35-44	L
13	Dr. M. G.	Researcher / Technical University of Crete	m	35-44	L
14	Dr. D. A.	Researcher / Institute for Mediterranean Studies, Forth	m	35-44	L
15	Dr. I. D.	Researcher / Hellenic Mediterranean University	m	35-44	L
16	S. S.	Researcher / Technical University of Crete	f	35-44	L
17	K. S.	Researcher / Technical University of Crete	m	35-44	L
18	Dr. A. K.	Researcher / Technical University of Crete	m	35-44	L

Due to Covid restrictions in place during the period of the final stakeholder workshop the organisation was based on small groups via online meetings. A total of 18 persons (6 female and 12 male) have discussed project findings organized in meetings during various dates in February and March 2021. The main groups were farmers, researchers and agronomists.

II. DISCUSSION OF PROJECT FINDINGS

A. Research findings

The SoilCare experiment was conducted on three farm fields (olive orchard, fruit orchard and vineyard) managed by farmers in three different areas of Chania, Crete, Greece. The olive orchard is located in Astrikas region, in an altitude of about 260 m and covers an area of about 3000 m^2 with a slope gradient of about 6%. The minimum to no tillage practice was adopted as an erosion mitigation practice for the olive orchard test site. The fruit orchard (Orange and Avocado) is located in Koufos region in an altitude of about 86 m and covers an area of about 2000 m^2 with a slope gradient of around 10-15%, and the different erosion rates between the two plantations were measured. The vineyard is located in Alikampos region in an area of about 3000 m^2 and an altitude of about 254 m. The slope gradient of the field is about 15%. The topsoil of all sites has a clay loam texture according to the USDA classification system. In the vineyard site the cover crop was tested as an erosion mitigation practice.

The tested practices within the fields indicate that Soil-Improving Cropping Systems (SICS) application seems to play an alleviating role in soil loss processes, therefore it is recommended to be further communicated properly to various target audiences with a main focus on farmers.

The most remarkable research findings for each crop type are:

(i) for the Olive Orchard test site:

- *No tillage practice is substantially beneficial for controlling soil erosion (over 20%), improving soil health and keeping good soil structure.*
- *Olive farmers should consider reducing tillage practices in olive orchards, control the tillage depth, and at the same time limit its application especially during severe drought periods.*
- *Apart from tillage, irrigation also increases soil erosion since irrigated trees are less resilient to water stress due to shallow roots.*
- *The biological health and condition of the no-till plots were clearly better compared to the tilled plots.*
- *Water and solute movement as well as soil aeration are appropriate even in the case of no-till.*

(ii) *for the* Fruit Orchard test site:

- *Crop type change (avocado) has a substantial impact on soil erosion/deposition (25% less).*

- *Avocado farms, besides significantly higher financial benefits, can also maintain a comparably overall good soil quality with a high content of soil organic carbon concentration, good status of solute movement, soil aeration and biological health.*

(iii) for the Vineyard test site:

- *Crop cover treatment (vetch) has a substantial impact on soil erosion/deposition (over 16%).*
- *Vetch application is an inexpensive solution and is recommended to control soil erosion.*
- *The correct application of cover crop is a determinant in improving soil quality.*

The experiment demonstrated that soil improving cropping techniques have a significant impact on soil erosion and as a result on soil water conservation that is of primary importance especially for the Mediterranean dry regions. As reported, tillage erosion is one of the most important processes of land degradation in cultivated areas. The effect of tillage in soil erosion was also recorded during the SoilCare experiment even for the minimum tillage practice. Results of the study also showed that crop cover treatment (vetch) and crop type change have a substantial impact on soil erosion. The proposed sustainable soil improving practices have already been applied in many parts of the region. Especially the change from orange to avocado trees has been adopted by many farmers as a response to the reduced orange prices and the high income from avocado cultivation. The results highlighted the crucial role of soil improving cropping systems for sustainable land management.
The demonstration of the local soil erosion threat was of practical use to most stakeholders, especially those that live and work with the local land. Those stakeholders were able to relate

to the major findings described. Local stakeholders underlined the fact that soil erosion mainly depends on geomorphology (slope), soil type, vegetation cover, climate, socio-economic and policy drivers, and human activities as well (land management and soil conservation techniques). All stakeholders agreed that the major consequence of soil erosion is essentially the reduction of soil fertility. In general though, soil erosion poses a limitation to agricultural production (and thus income), and therefore after a point production/income decreases. Most stakeholders perceive this limitation in production (or the subsequent decrease in income). Moreover, olive orchards and vineyards often suffer from extreme soil erosion by water due to farm slope and recent intensification of till practices.

B. Discussion of research findings

After the end of the online presentations, the participants, both men and women, and especially the farmers, raised some useful questions. More specifically, the olive groves' farmers wanted some clarifications regarding tillage avoidance especially in dry season, as well as tillage effects on water holding capacity. Furthermore, the vineyard farmers showed particular interest in the application of the experiments. Specifically, they wanted to be informed about the way that bulk density is measured, the range of its values that is considered sufficient, the depths at which the research team got the samples, as well as the way that the

earthworm experiment was applied. They were also interested to learn the measured soil organic carbon rate at both examined plots (vetch or no vetch cover). The orange cultivators raised also some interesting questions concerning the project findings. They focused on the fewer measured earthworms in the avocado's plot and they wondered whether avocados were actually reducing biodiversity. Due to this point of view, they were interested to understand the way of further improving the biological health and condition of soil on avocado trees. The orange farmers wanted also to clarify the effect of saturated hydraulic conductivity measured higher on the avocado trees than on the orange orchards. They also wondered whether the reduce in soil erosion in avocado trees was due to the slope of the studied plot, and whether in fields with higher slopes this reduce may not be so noticeable. A very important question raised was whether an avocado market will exist for the trees currently planted which will be put into production in five years.

Afterwards, the attendees were requested to validate whether the project findings were plausible and/or in line with their understanding. The soil specialists/consultants (three males) and the researchers (five males and two females) had well understood the project results in the three fields of its application. Concerning the farmers, the results were generally perceived by most of them. The vineyard farmers, a male and two females, pointed that the results were clear and plausible, since the case studies' fact sheets were very helpful to understand the conceptualization of the problems faced in the three field studies, as well as the results obtained. Regarding their vineyards, they understood the project's positive results on their fields, pointing out that the vetch cover crop is easy to be applied. Furthermore, the olive groves' farmers, a female and a male, found the results highly plausible to their understanding, and the no-tillage practice feasible. One of them (male) had experienced applying deep tillage for a few years in a field, in combination with less available water for irrigation, which resulted to a direct impact to the yield. As for the oranges' farmers, one of them (male) had no previous experience with the proposed crop switch, despite of current thoughts about planting avocado trees. The other oranges' cultivators, a male and a female, realized that switching crop to avocados will bring them a great financial profit in long-term, while at the same time soil erosion will be reduced in their fields. Moreover, they understood the presented positive impacts from the crop switching, and were particularly impressed by the higher magnesium, the higher soil organic carbon rate, the considerably higher hydraulic conductivity, and the fewer weeds in the avocado tree plot, compared with the orange orchards.

C. Impacts that have happened

The stakeholders were asked for verifying any benefits that have already arisen from the "useful" practiced project findings thus far.

- ✧ An olive orchards' farmer (female) stated that she already expanded the no-till treatment to new fields, achieving reduced soil erosion and unexposed tree roots.

Thereafter, the participants were requested to identify the benefits that they gained from SoilCare already.

- The olive groves' farmers, a female and a male, have ceased considering the benefits of established cultivation practices as important, underlining the useful information about the significant extent of the soil loss even for minimum tillage. They were satisfied with the non-negative effects of no-tillage, especially with the results concerning the biological health of the soil.
- The vineyard farmers, a male and two females, gained better understanding of their cultivations and soil functions, as well as better knowledge of the effect of various factors on the soil's biophysical parameters. In addition, they are currently aware of the risk of soil erosion on their fields, and of the inexpensive solution that the vetch cover crop provides, which works well to reduce soil loss. Furthermore, one of them (female) pointed out that she was informed about the Sustainable Development Goals (SDGs) and the way that these are introduced to future policies and are connected to farming practices.
- The orange's cultivators, two males and a female, gained also better knowledge of their fields, as well as of the soil erosion's negative impacts and the way it can be avoided. In addition, one farmer (female) noted that she was already confused due to the very low market price of oranges; currently, due to the information from the implemented experiments by SoilCare, she needs to communicate more with scientists and soil consultants about her crop's soil quality.
- Agronomists/consultants, three males, have experienced of land owners with reduced interest for practicing SICS, especially those with a lower education level. They have understood that some farmers do not seek even regular testing of soil quality of their fields, and they are reactive rather than proactive. Despite that farmer's cooperatives and individual agronomists have already important knowledge and means to assist farmers, land owners will seldom invest in a long-term plan to increase efficiency and promote SLM practices. Thus, the consultants noted the necessity to inform farmers for soil improving techniques, as well as the requirement for a properly training in applying correctly these techniques.
- The researchers, five males and two females, have gained significant information about the way that SICS can improve soil quality in each of the three studied fields, especially in combination with mulching, manure, liming and irrigation time setting. One of them (female) underlined the knowledge about the profitable avocado crop, which at the same time ensures soil quality.

D. Future impacts

Thereupon, the stakeholders were asked for identifying the benefits that they find "useful" from the project findings, for the future.

- An olive grove's farmer (male) is willing to apply the proposed no-tillage practice to one of his fields.
- A vineyard farmer (male) was very satisfied with the positive results of the cover crop application to the plot, thus he is interested to apply the planting vegetation to the whole field, or/and to additional plots. The other vineyard farmers (two female) agreed

to test a site in their field to examine some of the methods presented. In particular, they are willing to apply the experiment of measuring bulk density of the top and bottom soil to verify the state of water and solute movement, as well as aeration of the soil. They are also interested in applying the earthworm test for the biological health and condition of soil. One of the latter was also interested about more information regarding related policies and SICS practices across Europe.

- As for the oranges' growers, one of them (male) is determined to keep on switching the rest of the orange orchards to avocado trees. The other two oranges' cultivators, a male and a female, are thinking of applying a more standardized monitoring in their fields, which will definitely include the conduct of chemical analyzes of soil quality to understand if any trace elements are missing, and the implementation of the earthworm experiment.
- The consultants, three males, are motivated to use the results and present them in workshops and/or other organized events aimed at farmers.
- Some of the involved researchers, a female and three males, proposed to disseminate the information about the new effective SICS to their partners, as well as to create synergies with SoilCare project. Other researchers, two males and a female, are interested to monitor the study fields for another 2-3 years, with the agreement of the farm owners, to examine if soil erosion continues to decrease in the SICS plot and at what rate.

Afterwards, the participants were requested to state the way they could disseminate the project findings to more people who can benefit from them.

- Three female farmers suggested that they might share the results with other farmers with whom they work at the oil mill, either through the vine grower's cooperative, or just through discussion with nearby growers. On the other hand, a male farmer (owner of study site) pointed that he already communicates the results with fellow cultivators.
- A female farmer recommended that the best way to share the findings is probably through organized events at the local level, e.g. co-organized with local organizations, municipalities, farmer cooperatives. Another farmer (male) suggested that the scientists should share the results at the farmers' local village cafe after the end of the Covid-19 pandemic. One other cultivator (male) proposed the dissemination through an informative discussion on the local media.
- The consultants, three males, offered to organize training events for farmers in order to strengthen their skills on innovative soil improving mechanisms.
- Some researchers (three males) suggested that brochures and workshops would be a significant way to inform stakeholders about the findings. Others, a male and a female, proposed to conduct in situ exhibitions of SoilCare case studies in Crete, whereas the rest of them, a female and a male, added the video demonstration of SICS solutions, as well as guidance documents about new soil practices addressed both to farmers and agronomists, for suggestions.

Subsequently, the attendees were asked to report the way that they would like to be supported in using or implementing project/research findings.

- One olive orchards' farmer (female) would like to be subsidized to change plowing machine that controls tillage depth, or maybe to buy a branch shredder. On the other hand, the other olive farmer (male) is looking for policy opportunities. It was also punctuated that government should help the agricultural associations to further develop.
- The vineyard farmers (a male and two females) stated that the free supply of vetch seeds would be an incentive to continue planting vegetation and a "compensation" for the extra work needed. They also seek for subsidy for new machinery that allows reduced tillage, to implement properly the cover crop practice. Especially the one female vineyard farmer looks for a proof of concept in a wider scale, as well as dedicated consulting services provided by the state.
- Regarding the oranges' farmers, a male and a female, pointed out that the cost of avocado trees has become very high, thus they seek for subsidy because they can't afford of getting a loan. The other oranges' cultivator (male) stated that the plants' market is currently very expensive, and thus it should be controlled; he also identified the need for policy towards crop change, in coordination with guidelines from the competent authorities.
- The consultants, three males, seek for additional seminars on the way that they should train the farmers; they claim that the training sessions should be organized by government agencies and emphasize to SICS and their benefits to farmers.
- Some of the researchers (three males) seek for funding of research projects for new SICS mechanisms and involvement of both farmers and stakeholders. Others, two males and two females, look for a proper collaboration of researchers and farmers/owners of fields, because they feel that connectedness is the key to implement innovation.

Thereafter, the stakeholders were requested to mention one thing they want to remember from the presented impacts on the final online meeting.

- The olive orchard's farmers, a female and a male, focused either on the earthworm experiment application and no-tillage benefits to soil compaction, or on the need for cooperation between farmers, paying attention on the exchange of knowledge regarding experimental cultivations, respectively.
- The vineyard cultivators, a male and two females, displayed interesting views. The male farmer (owner of study site) was pleased with the entirely positive vetch cover crop findings to his field. A female farmer showed interest about the different experiments that could be applied in order to test the biological health and condition of the soil, whereas the other female farmer was interested in the policies' opportunities for facilitating the uptakes of SICS in Crete and wider.
- An oranges' cultivator, male, (owner of the study site) focused on the benefits of the physicochemical characteristics of avocados compared to the major cultivation of the region which is the orange crop. Another oranges' farmer (female) was more interested about the significant decrease of the mean soil erosion in the avocado's field compared to the orange orchards during the 2.5-year monitoring, together with a comparably overall good soil quality of avocados.

- The agronomists/consultants, three males, identified the importance of transferring all this displayed information to the interested parties.
- Educational institutions lack the legislative freedom and means to interact with stakeholders for pilot or prototype SICS practices that would motive farmers to use resources from educational based startups to produce state of the art results. Many researchers, two males and three females, verified the necessity of properly information of farmers about SICS implementation benefits and the requirement of building trust in order to persuade them abandoning traditional practices in favor of new methods. Other researchers, three males, emphasized on the prerequisite help of farmers strengthening their technical skills through continuous learning.

Finally, the participants were asked to mention one thing that they want to do with what they learned from the online workshop.

- The olive orchards' farmers, a female and a male, punctuated that they plan to move gradually to no-tillage at all the fields and crops of their belong, either to stop the systematic tillage that has been done so far to control weeds, respectively.
- A female vineyard farmer wants to build more trust with researchers and consultants regarding new SICS practices. The other vineyard farmers, a male and a female, are either determined to apply the plant vegetation technique to all their fields, or to test the potential of cover crop treatment, correspondingly.
- The oranges' cultivators, two males and a female, expressed interesting aspects. The male farmer (owner of study site) has a more strengthened belief to change the rest of the orange orchards to avocados due to the workshop discussion. The other male farmer would like to get better information on policies. On the other hand, the female farmer intends to trust hereafter soil specialists and consultants in soil health practices, as well as to network with fellow farmers to jointly adopt innovative cropping practices.
- The consultants, three males, aim to include the displayed findings on training programs emphasizing on soil sustainability and farmers.
- Some of the researchers, a female and three males, plan to disseminate all the information gained to research partners and interested stakeholders. Other researchers, two males and a female, identify the lack of financial motives (or motive awareness) for farm owners, because of which the farmers are forced to make short term planning and focus on short term profit maximization. Therefore, the researchers intend to pressure the Region of Crete and municipalities to ensure subsidies from the EU for farmers who are willing to follow new practices which improve soil quality and thus agricultural production of their crops. They want to ensure that SICS practices will be embedded in all funding and subsidies. Specifically, the authorities should provide specific incentives to farmers for adopting all the presented SICS measures, namely minimum or no tillage, increase of cover crops' areas, switching of cultivations to more profitable and sustainable ones. The researchers also aim to demand that the authorities should raise awareness.

References

Panagos P, Christos K, Cristiano B, Ioannis G. 2014. Seasonal monitoring of soil erosion at regional scale: An application of the G2 model in Crete focusing on agricultural land uses. International Journal of Applied Earth Observation and Geoinformation 27:147–155.

HUNGARY

Final stakeholder workshop report – Keszthely, Hungary

Zoltan Toth – participant contact

Date of workshop: 2nd February 2021

Location: research field of Georgikon Campus, Hungarian University of Agriculture and Life Sciences (formally: Georgikon Faculty, University of Pannonia, site is the same, only organisation has been changed)

Outdoor meeting was organized in accordance with the COVID-19 pandemic regulations with limited number of participants, forming groups of 10 people each.

Participants:

Different groups of stakeholders were invited to the forum. Among them there were small and large scale farmers, staff members of the Hungarian Chamber of Agriculture, consultants and staff members of the authorities dealing with agricultural and environmental affairs, as well as members of the Agricultural and Rural Youth Association. Some farmers newly joined our Stakeholder Community for this workshop.
Number of participants: 38 (5 female, 33 male, total invited:50)

Topic and program:

1. Introduction of participants, site conditions and challenges

2. Presentation of findings

Main topic was the introduction of the main findings of our experiments run to test and demonstrate the effects of different soil improving technologies such as organic amendments and reduced tillage. For helping to follow findings under outdoor conditions handout material was completed and spread amongst participants.
The present status of crops on the different experimental plots were also observed and visually assessed. Soil profile and soil characteristics were also studied in the site to provide better and more complex understanding of the results and processes in the soil-plant-atmosphere system.

Questions / notes / discussions related to presentations:
It was concluded that small scale farmers have limited resources and traction power for investing in expensive new technology/machinery, so they pay less attention to promotions focusing on reduced tillage equipment/technologies.

For providing better soil biology, importance of microbiological support tools for soil health and optimal soil functioning had arisen. Some of the stakeholders are sceptic about the effectivity of the microbiological product, since their effect depends on several biotic and abiotic environmental factors. It was agreed the first step to improve soil microbiological status is to promote favourable soil properties for biological activity, otherwise neither native nor external microorganisms can work intensively.

In addition to the others, general importance of the adaption of timing of agrotechnical applications to the development stages of crops was agreed to have essential importance to provide effective, productive and environmentally sound crop production.

3. Stakeholders feedbacks

Under outdoor field conditions „flip-chart paper" method was not realistic to do, Stakeholders opinions were collected by oral discussions.

Main questions:

- (validation) Are project results plausible and/or in line with your understanding?
  Answer: yes, they are, but maximizing profit / economical sustainability is still the priority.
- (usefulness) How could you use results of this project in your work (specify which results can be used in which ways)?
  Answer: organic manure has limited availability and long-distance transport is not economical, but farmers, having livestock apply regularly. Other ways to obtain manure to provide straw for livestock farm in return for manure, or replace manure by different bio based organic fertilizers, or by-products (composts and different organic wastes, etc.) as well as green manure (in case of green manure/cover crop water consumption should be taken into consideration under arid/semiarid conditions).
- How could we get our findings to more people who can benefit from them (and how you could help)?
  Answer: in teaching academic people involve these result into the curricula, fact sheets may be spread amongst farmers using official networks like farmers associations, chambers of agriculture, and farmers adapting these Soil Improving Cropping Systems (SICS) can also be good messengers of SICS in their closer community.
- What benefits have you gained from SoilCare already?
  Answer: non-inversion tillage, cover crop production and mulching with straw are adapted in many farms and importance of crop rotation is more and more recognized for its beneficial effect on pest management, soil conservation and biodiversity.
- How would you like to be supported in using or implementing project/research findings?
  Answers: availability of independent experts for consultation in adapting new technologies, making decision for buying new equipment or making new investments, would be a real support.
- One thing I want to remember (method: round-robin)?
  Answers:
    - ecological approach of farming,
    - look of the surface is not everything,
    - there are many „miners" of nutrients and builders of soil structure under the soil surface,
    - root is the hidden half of the plant and needs to be cared like canopy

- One thing I want to do with what I learned today (method: round-robin)?
  Answers:
    - recycling straw regularly,
    - paying more attention to stubble management,
    - more consideration on species of cover crops grown in a rotation,
    - replacing mouldboard ploughing by non-inversion tillage methods more frequently

SoilCare impacts to date (based on post-it exercise)

- Most of the farmers recognized the importance of the ecological approach of farming
- Many of the farmers apply organic amendments on the field and pay attention to manage residues on the field properly.
- Some of the farmers have purchased non-inversion and reduced tillage equipment.

Plans/aspirations for future impact (based on final exercise)
Non-inversion tillage, organic amendments, cover crop production and mulching with straw have been adapted in many farms. Importance of crop rotation is more and more recognized for its beneficial effect on pest management, soil conservation and biodiversity, as well as in mitigation of extreme weather events. As a tool of dissemination in order to achieve impact of findings in larger groups of society stakeholder forums and demonstration events are proved to be effective activities. Even reporting results and experiences from other study sites (collected in WP4 and WP5) allows a more complex approach of the topic to provide a more convincing way of dissemination

ITALY

Report on final stakeholder meeting

Legnaro study site (Italy)
Date: 29/01/2021 9:00-12:00
Place: the meeting took place online on Zoom platform (Figure 1)
Participants: 30, 6 females and 24 males

Category	Researchers	Farmers	Students	Technician	Policy maker
Number	9	7	4	5	4

Figure 1. Picture during the online meeting

Summary

Meeting structure

The meeting started around 9:00 with the presentation of the 30 participants. Afterwards, Prof. Antonio Berti gave a presentation with general introduction to SoilCare project and brief excursus on previous project years (Figure 2). Then, Felice Sartori presented the finale project results with particular regards to crop yield, penetration resistance, bulk density and earthworm density (Figure 2). Finally, a general discussion and questions took place as reported in the program in Figure 3. The meeting closed at 12:00.

Figure 2. Some moments of the meeting: Prof. Antonio Berti (left) and Felice Sartori (right).


SoilCare
SOILCARE FOR PROFITABLE AND SUSTAINABLE CROP PRODUCTION IN EUROPE

Progetto europeo SOILCARE, (www.soilcare-project.eu

STAKEHOLDERS MEETING

Venerdì, 29 gennaio 2021 ore 9:00

Al fine di garantire la sicurezza di tutti i partecipanti e il rispetto delle normative, **l'evento tramite il software Zoom** https://zoom.us/download

PRESENTAZIONE

Lo scopo finale di SoilCare è determinare il potenziale di sistemi colturali migliora Europa, identificando con sperimentazioni sito-specifiche quelli che hanno impatt redditività e la sostenibilità.

Realizzare un'indagine per identificare i sistemi colturali che possano essere consi miglioratori del terreno, identificare i benefici e gli svantaggi, determinare gli impa potenziali sulla qualità del terreno e dell'ambiente.

PROGRAMMA

9:00 Accesso e registrazione al webinar

9:15 Presentazione del progetto SoilCare e del caso di studio di Legnaro – *Prof. A*

9:45 Presentazione dei risultati del progetto (2018-2020) – *Dott. Felice Sartori*

10:15 Coffee break

10:25 Tavola rotonda e discussione con i partecipanti – *Dott.ssa Ilaria Piccoli*

11:00 Saluti finali

COME PARTECIPARE

L'evento sarà ospitato nella piattaforma zoom. Per collegarsi utilizzare il seguente
https://unipd.zoom.us/j/83157061073?pwd=SzFuUHdYOVpaSk9NSkg1S2NjTVpKU
ID riunione: 831 5706 1073 Passcode: soilcare

Per info:
Felice Sartori 3497820575, felice.sartori@phd.unipd.it **Antonio Berti** antonio.berti@uni

Figure 3. Program of the meeting (in Italian)

Exercise and discussion results clustered by stakeholder classification

Exercise 1

Exercise: validation and usefulness. Stick flip-chart paper to two walls and invite participants to answer the following questions, making one suggestion per post-it and clustering similar post-its together

Validation

Are project results plausible and/or in line with your understanding?

Summary of discussion result:

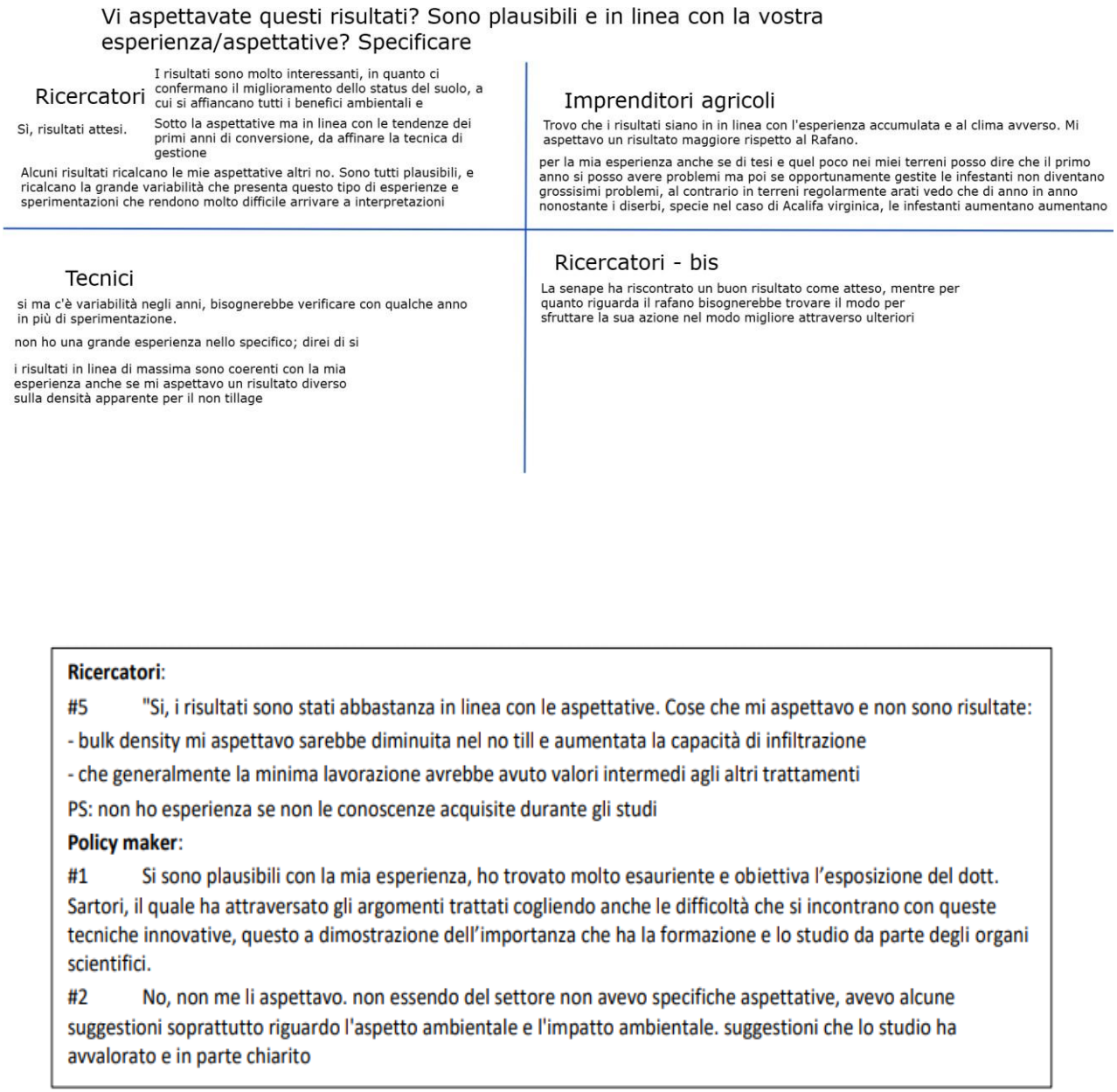
Researchers found project results in line with their expectations. In particular, they believe presented results interesting and encouraging, because they confirm the positive effect of adopted SICs on soil quality and soil physics despite the drawbacks connected with the transition period between conventional to conservation agriculture.

Farmers they found the results in line with their expectations except for tillage radish (they expected better performances linked to the use of tillage radish as cover crop).

Technician found the results in line with their expectations even if the higher results variability may suggest the need to increase the number of experimentation years.

Students expected better performances with tillage radish with respect to other cover crops.

Policy makers learned more technical details about the SICS, confirming the positive environmental effect of conservation agriculture, together with the need of extensive studies at farm scale.



Ricercatori:

#5 "Si, i risultati sono stati abbastanza in linea con le aspettative. Cose che mi aspettavo e non sono risultate:

- bulk density mi aspettavo sarebbe diminuita nel no till e aumentata la capacità di infiltrazione
- che generalmente la minima lavorazione avrebbe avuto valori intermedi agli altri trattamenti

PS: non ho esperienza se non le conoscenze acquisite durante gli studi

Policy maker:

#1 Si sono plausibili con la mia esperienza, ho trovato molto esauriente e obiettiva l'esposizione del dott. Sartori, il quale ha attraversato gli argomenti trattati cogliendo anche le difficoltà che si incontrano con queste tecniche innovative, questo a dimostrazione dell'importanza che ha la formazione e lo studio da parte degli organi scientifici.

#2 No, non me li aspettavo. non essendo del settore non avevo specifiche aspettative, avevo alcune suggestioni soprattutto riguardo l'aspetto ambientale e l'impatto ambientale. suggestioni che lo studio ha avvalorato e in parte chiarito

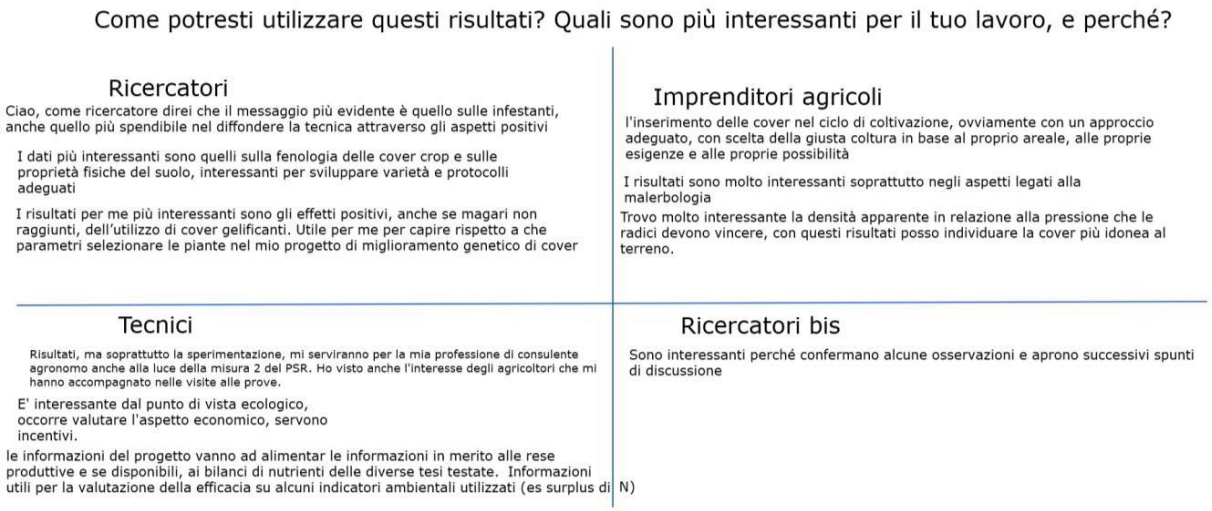
Figure 4. Stick flip-chart results on validation question (in Italian).

Usefulness

How could you use results of this project in your work (specify which results can be used in which ways)?

Summary of discussion result

- For researchers and students weed infestation under no-tillage management and cover crop phenology seemed the most interesting results, to be useful to make clear protocol on how to deal with conservation agriculture. Moreover, they suggested to explore the effects of the SICS on water cycle.
- Farmers are now considering to including winter cover crop inside their crop rotation. Nevertheless, they understood that it is important to select the correct cover crop species and variety considering local pedoclimatic conditions.
- Technicians underlined the need to make precise economical evaluation. The environmental impact of this SICS resulted the most interesting result, together with the use of environmental and agronomic indicators as an alternative to yield in the SICS effectiveness evaluation.
- Policy makers found the meeting useful to increase their technical knowledge in this field, to be more effective and efficient in the law-making process and in the public relations. They affirmed to have gained more awareness that will be useful in the public debate.



Ricercatori:

#5 È generalmente utile sapere che eliminando delle lavorazioni si può arrivare ad ottenere risultati di resa simili al sistema tradizionale. Per me sarebbe interessante approfondire l'aspetto "suolo e capacità di stoccaggio d'acqua" per capire come minima lavorazione / no till influenzino il fabbisogno irriguo.

Policy maker:

#1 Posso utilizzare questi risultati per informare e rendere più consapevoli i cittadini, riguardo alle ricerche ed innovazione in ambito agricolo.

#2 Come accrescimento della mia conoscenza da applicare all'approccio alle iniziative politiche per esempio di incentivo all'agricoltura conservativa. Le conclusioni riguardo la necessità di preparazione ed esperienza dell'agricoltore, la necessità di avere possibilità di utilizzo di specifici macchinari. quando mi approccerò al tema dell'agricoltura conservativa ora avrò conoscenze e strumenti in più per assumere decisioni o proporre di assumere decisioni politiche più consapevoli e mirate.

Figure 5. Stick flip-chart results on usefulness question (in Italian)

Exercise 2.1

How could we get our findings to more people who can benefit from them (and how you could help)? Provide your name if you offer help

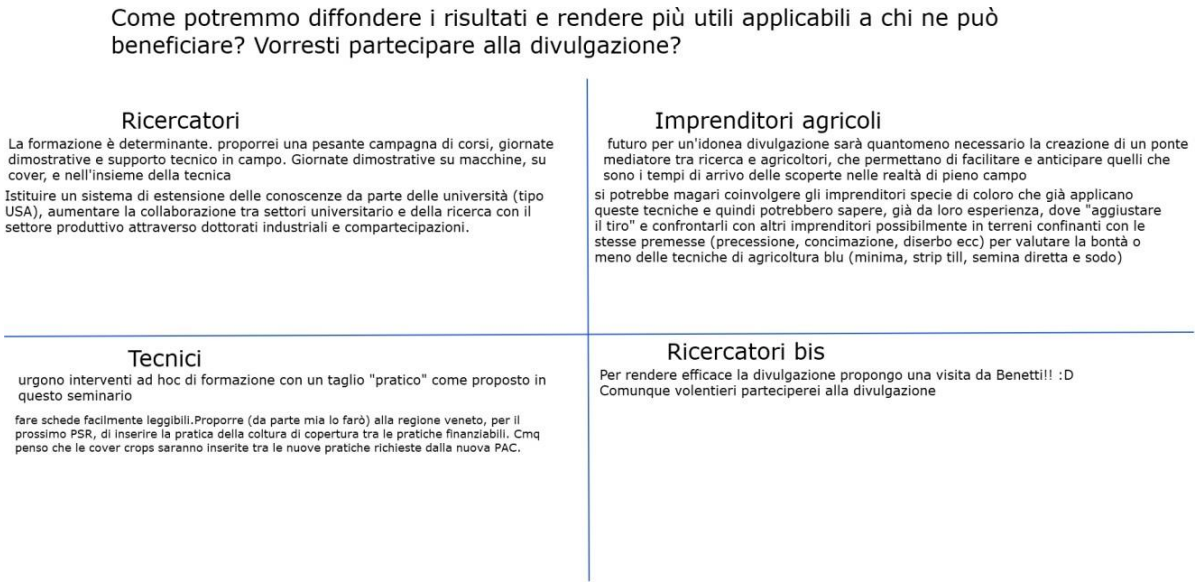
Summary of discussion result:

Researchers and students underlined the need of a linkage between University, farmers, and companies. They suggested to create an intermediate institution to diffuse the knowledge from researchers to farmers. Another strategy is to write informative articles and eventually videos.

Farmers confirmed the need of a link between University and farming community. They also suggested to involve farmer in the researches, with farm scale experiments.

Technicians reported the need of a simplified legislation to regulate the subsidies and practical seminars both for farmers and advisors.

Policy makers were available to diffuse and disseminate the positive results presented. Moreover, they suggested to discuss the opportunities of subsidies for SICS implementation with the institutions (e.g. regional department)



Ricercatori:

#5 Sicuramente attraverso articoli divulgativi, ma potreste anche fare dei video di divulgazione!

Si parteciperei se serve.

Policy maker:

#1 Si volentieri. Credo sia la base per ottenere buoni risultati nel tempo.

#2 Classici mezzi e luoghi di divulgazione, per quello che mi compete suggerirei anche una attività di sensibilizzazione dei decisori politici da fare negli spazi e nei momenti di discussione previsti nei luoghi istituzionali (commissioni agricoltura, direzioni generali competenti, assessorati ecc.)

Figure 6. Stick flip-chart results on exercise 2.1 (in Italian).

Exercise 2.2

What benefits have you gained from SoilCare already?

Summary of discussion result:

Researchers and students were interested in all the results. The effects on weed population, seeding date, and the winter sensitivity of cover crop resulted the three most interesting aspects, but also the other results were appreciated.
Farmers appreciated the reported technical information. They will try to improve their sustainability and efficiency project outcomes.

Technicians underlined the need of a permanent exchange of views between researcher and farming community, to share the results and discuss together the possible applications.

Policy makers were interested about the environmental benefits of adopted SICS. They learned technical and scientific information, that will be useful in the policy making process.

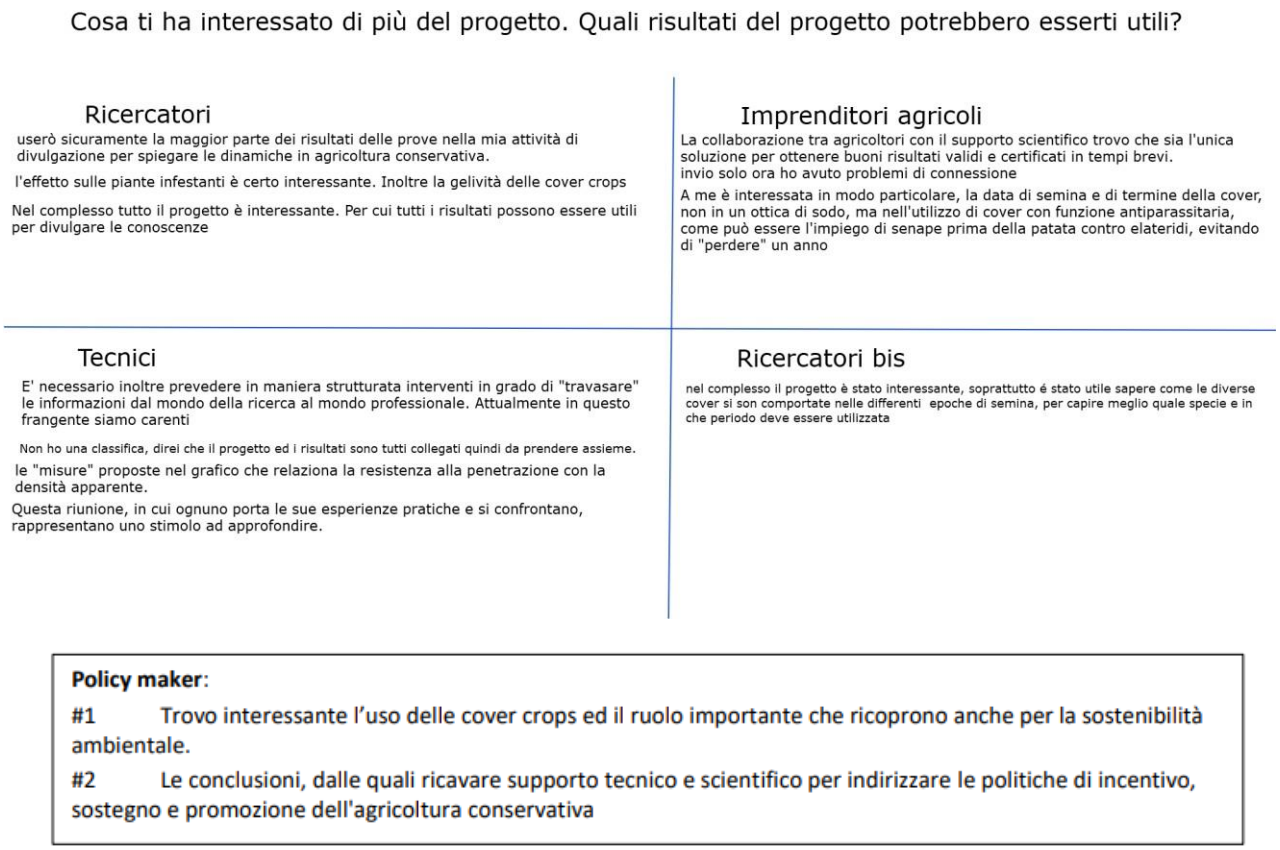


Figure 7. Stick flip-chart results on exercise 2.2 (in Italian).

Exercise 2.3

How would you like to be supported in using or implementing project/research findings?

Summary of discussion result:

Researchers and students underlined the need of on-filed demonstration activities and farmer cooperation. They also stressed that the agroecosystem is complex, and data interpretation is not easy. Finally, they reported the need of support in the plant variety selection for the SICS application.
Farmers confirmed researchers' suggestions, adding that they need independent and objective advice and information on SICS. They specified that one of the main limitations to SICS application would be farmers' resistance to change.
Technicians asked for more result sharing, in form of articles, on-filed demonstration activities and meeting. They also required the definition of a clear protocol to evaluate SICS performances at farm scale.

Policy makers needs researches availability for informative meeting with the citizens.

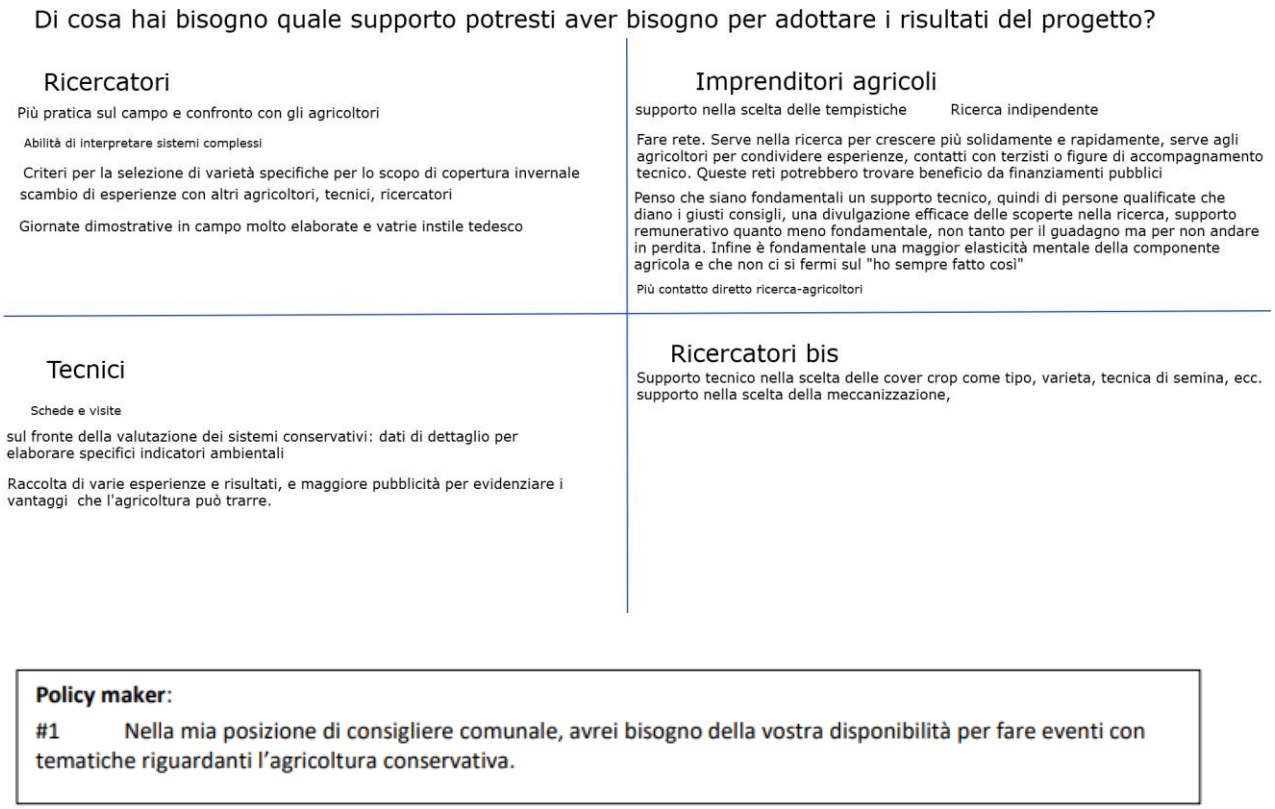


Figure 8. Stick flip-chart results on exercise 2.3 (in Italian)

Exercise 3

One thing I want to remember or one thing I want to do with what I learned today.

Summary of discussion result:

Researchers and students were stimulated to study in detail the cover crop frost resistance.

Farmers were mainly interested in the cover crop results and left the meeting with many ideas on the possible applications in their farms.

Technicians hope to find longer term results. They learned the importance of the weed management in the adopted SICS.

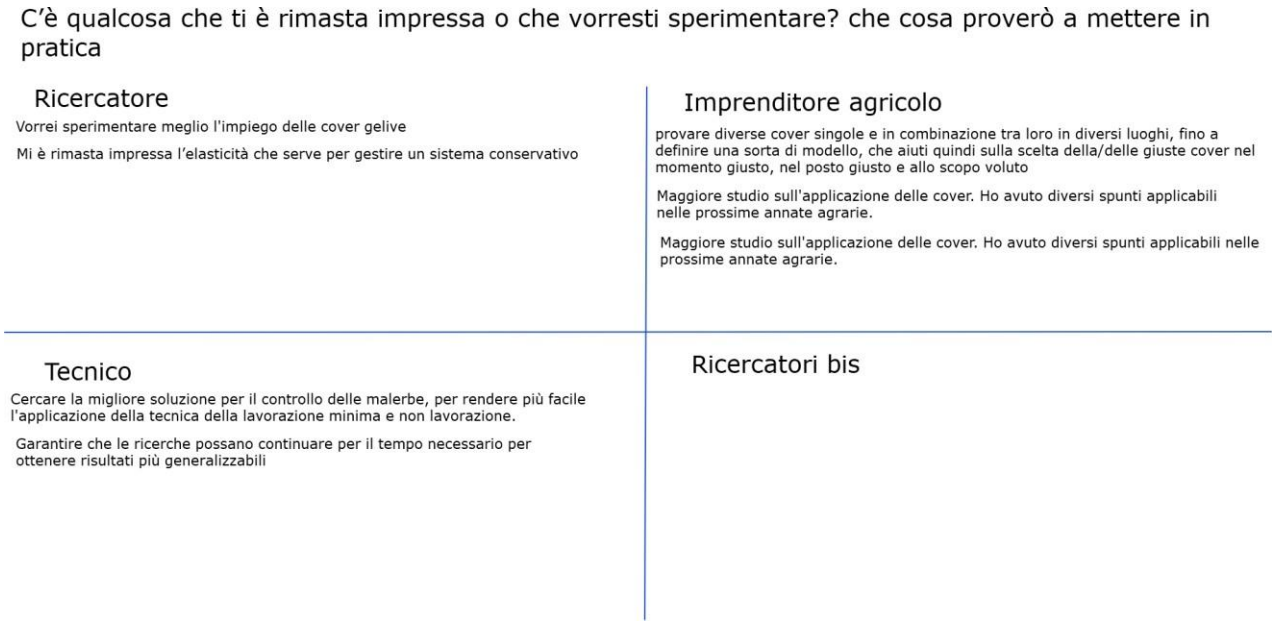


Figure 9. Stick flip-chart results on exercise 3 (in Italian).

NORWAY[10]

[10] Kamilla Skaalsveen, Frederik Bøe, Till Seehusen, Jannes Stolte

Introduction

The purpose of the workshop was to present and evaluate the results from the project. The workshop was carried out virtually as the current COVID-19 situation did not allow us to arrange a physical meeting. The arrangement was carried out February 25th 2021 from 9 to 11.30 am and started by an introduction by Kamilla Skaalsveen (NIBIO) welcoming the participants and presenting the agenda, the aim of the workshop, a reminder of aims and results from earlier SoilCare workshops, and a presentation of the recently produced policy brief for Norway. Jannes Stolte (NIBIO) presented the status of the SoilCare project, informing about the project objectives and the progression. Else Villadsen from the Norwegian Agricultural Extension Service gave a talk about their experiences in the cover crop field trial at Øsaker. The extension service was responsible for the operation of the Øsaker field trial and Else was able to share valuable information about their practical experiences. Following, Frederik Bøe (NIBIO) presented the results from the Øsaker field trial, evaluating cover crops as a soil improving practice in Norway. Till Seehusen presented his findings from the second Norwegian field trial at Solør where biological compaction release by deep rooted cover crops has been tested. By the end of the presentations the participants were welcomed to ask questions or make comments about the project results.

There were 22 people participating the Workshop, which is a higher number than during our former workshops. We assume that the higher participation was due to that there might be a lower threshold to attend a virtual meeting as it is less time consuming and does not require traveling. There were five researchers (NIBIO), three representatives from the Norwegian Agricultural Extension Service, four from the County Governor, six from the Norwegian Agriculture Agency, two farmers, one representative from an agricultural high school, one representative from the Inland Norway University of Applied Sciences, and one representative from an interest organisation. 11 of the participants were women and 11 were men.

The participants were divided into four groups (randomly generated by Teams) to discuss the workshop tasks. We were using Microsoft whiteboard with post-its for the groups to add comments and answer questions simultaneously (see Appendix 3 for an example). There were three whiteboard links all together, consisting of two questions per link. We did, however, have some technical issues as the whiteboard webpage/software stopped working. The participants were therefore asked to discuss the questions within the groups, take notes, and present their results to the rest of the groups by the end of the workshop.

Discussion of project findings

The main research findings and conclusions from the Øsaker cover crop field trial are summarised below:

- It has been proven difficult to establish and achieve sufficient density of cover crop plants in the small plot scale experiment in Øsaker, especially in years that are dry (2018) and in years with high precipitation (2019).
- occasionally high amounts of weeds (chickweed), as well as practical challenges, might have affected the growth of the cover crop species and the main crop in later years.
- High temperatures and low precipitation in 2018 resulted in poor plant growth and consequently an excess in mineral nitrogen in the soil, as illustrated by the high levels of mineral N in 2018 compared to 2019 and 2020
- Differences in soil organic carbon between years could be an effect of the summer drought.
- The plant species most often observed through field observations was vetch in the SN mixture and ryegrass in the SR and AR treatments. Crimson clover in the SN treatment and radish in AR treatment was observed occasionally.
- The results show a decrease in mean relative crop yield for treatments where legume cover crop species were included (Treatment SN and AN).

The main research findings and conclusions from the Solør biological compaction release field trial are summarised below:

- Low yields mostly due to unusual, poor weather conditions during the whole research period
- The growing season in this part of Norway is too short for a proper establishment of oil seed
- The experimental plots were comparatively small which made mechanisation challenging
- Alfalfa established an impressive root system and seems to be suited to loosen up soil compaction
- Alfalfa is costly to produce for the farmer

Discussion of research findings:

After the three presentations that were summarising the project findings, we welcomed the participants to ask questions or to make comments about the approaches and results. Their questions/comments were primarily focused on the experimental design, and one participant was asking why the spring and autumn sawn cover crops were attempted established within the same experimental blocks in Øsaker. The answer from Else Villadsen from the Norwegian Agricultural Extension Service was that this approach was undertaken because we wanted to

carry out the experiments in a controlled way, and that we did not have enough experience at the time when the field trials were initiated to predict the difficulties this would cause. She also explained that they had seen differences between the establishment of the cover crops in the field trials routs and in "real" systems by farmers. The extension service believes that the difference can be related to that the methods used by the farmers were differing from the ones used in the project field trials. Spreading the seeds by hand, which was the method used in the trials, led to poor establishment unlike farmers' fields where a centrifugal spreader was used. The timing of the field operations was also crucial for a good result. Cover crops are often highly prioritized by the farmers that the extension services are collaborating with, while the field trials unfortunately were harvested too late in the autumn. Generally, the spring sown cover crops were difficult to establish properly.

Further, direct drilling of cover crops was discussed and Else said that this technique might be more successful for plant germination. Early establishment was, however seen as the most important factor influencing the success of the cover crops, and if the farmer must use a different technique to be able to saw early enough, that is recommended instead.

The success of the cover crops was also highly impacted by slugs, which was an issue in the Øsaker field trial. One of the participants argued that the small size of the blocks would increase the risk of the crops being eaten by slugs. Larger routs and slug pellets would be beneficial for reducing the slug issues.

Some participants commented that they were surprised that crop rotations did not show any positive effects on soil organic matter levels. The time frame of the project is important in explaining this finding, as enhancing the organic content significantly is expected to take several years. Several participants commented that it would have been beneficial is the project field trials lasted for a longer time period as it is difficult to get significant results in only a few years due to changing weather conditions. A plausible explanation of the lack of changes in organic matter levels might also be the low return of organic matter from the crops as the three years of the field trials were challenging weather-wise causing low yields and returns to the soil (plant material). We still believe that there is a positive relationship between crop rotations and soil organic matter, but need longer term studies to show this. Farmers do, however, report good effects of implementing crop rotations (according to the extension service).

Regarding the compaction trial at Solør there were also questions about whether compaction of the subsoil is a common issue in Norway. Till, who is responsible for the compaction release field trial said that this a challenge in Norway as well, particularly when snow is isolating the soil, keeping the soil from freezing any lower than around 15 cm.

Impacts that have happened

The workshop groups expressed that they were pleased with the Norwegian study sites' focus on cover crops, which they thought was both interesting and useful, although some expected more significant results and larger effects. There seems to be an increasing focus on how to establish cover crops in Norway, what species can be established here, and what effects they have on both soil health, water quality/erosion and carbon sequestration. Some participants highlighted that the SoilCare project has been an important contributor in increasing the general focus on cover crops in Norway, both amongst farmers (cover crops used to have a "bad reputation" amongst farmers, which is slowly changing) and the general public. They found it beneficial that a large project like SoilCare was focusing on/ increasing people's awareness of soil improving measures such as cover crops.

Another important benefit from the project mentioned by several participants was the knowledge gained about the benefits and drawbacks of the experimental design of the field trials. Gaining more experience on how to successfully establish cover crops in Norway is important for both researchers, the extension service and farmers, and is a prerequisite for this measure to be successful. Experiential knowledge gained through the SoilCare project is therefore an important starting point for future research, and for achieving well established trials that can provide more information about the effects of the measure. Representatives from the County officer said that increasing our knowledge about the effects of cover crops in Norway is important for providing them with information that they need to make regulations and schemes for agricultural measures. They underpinned the importance of research dissemination and suggested that researchers should dear to be bolder in stating how research results should be interpreted and used. They wish researchers would take a more active role in interpreting what the results mean (although there are several uncertainties). Although the results from this project were too uncertain, they would appreciate more information about how they can be viewed in relation to other studies. This was, however, a general consideration, not specifically related to this study.

The participants requested more similar research, preferably long-term experiments so that the results can be verified easier, and knowledge about the effects of cover crops on more soil variables, and mapping of the suitability of more cover crop species, in collaboration with the extension services and farmers. One group suggested that it would be beneficial to consider more practically oriented research designs in future projects, representing larger systems, and by using farmers' own machinery for more representative results. Another group suggested that it is important to try and simulate a real farming setting when designing a field trial. The focus on cover crops and request for information amongst farmers is increasing, and knowledge about regional adaptation is important

Another feedback was that the project has also been useful for building networks both nationally and internationally (the latter primarily applicable for researchers), and for gathering people with different roles and experience. Others said that they appreciated the way we invited them to take part of the dialog through the workshop approach.

Future impacts

There were several suggestions of people who it would be beneficial to disseminate project results to. One of the groups stressed the importance to inform policy makers, farmers, the general public and governmental institutions like the county officer. In order to incentivize farmers to test and implement cover crops, support from e.g. governmental authorities is key. Another group said that the project results are important for everyone who is working with/in agriculture, but it is important to use the results carefully and in the context of similar studies as such results will vary. Other people that could be interested in the project results are representatives from the regional water boards, farmers and agronomy schools. They also suggested that producing some fact sheets of the project results would be useful, but also finding funding for extending the field trials for more years along with more dissemination of the results.

Funding for more research is important to produce more evidence and to increase our knowledge about the effects of cover crops in Norway. More evidence will also provide researchers with more ground to interpret the results. Both operating and managing filed trials requires a lot of work and one of the groups suggested that the data output from such trials should be collected in a database, particularly to create an overview of the performance of different cover crop species in different regions, techniques for sawing etc.

Appendix

Appendix 1. Workshop agenda.

Agenda

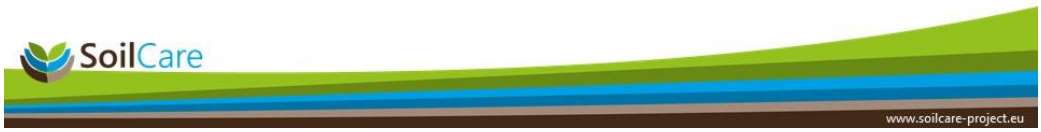
09.00 Velkommen!

09.10 Introduksjon (Jannes Stolte, NIBIO)
09.20 Presentasjon feltforsøk Øsaker (Else Villadsen, NLR)
09.35 Resultater fra feltforsøk Øsaker (Frederik Bøe, NIBIO)
09.55 Resultater fra feltforsøk Solør (Till Seehusen, NIBIO)

10.10 Spørsmål og diskusjon

10.25 Workshop oppgave 1 - "validering og nytte"
10.45 Workshop oppgave 2 - "formidling og fordeler"
11.05 Workshop oppgave 3 - "hva har vi lært?"

11.25 Avslutning



Appendix 2. We did not receive the fact sheets before out final workshop, so translated the policy brief and presented to the stakeholders instead.


SoilCare
SOILCARE FOR PROFITABLE AND SUSTAINABLE CROP PRODUCTION IN EUROPE
Policyanalyse:
OPPTAK AV JORDFORBEDRENDE TILTAK I NORGE
TRUSLER MOT JORDHELSE
Jordpakking
Erosjon
Tap av næringsstoffer
JORDFORBEDRENDE TILTAK FOR BEDRET JORDHELSE
Følgende jordforbedrende tiltak har blitt testet ut i de norske områdestudiene for å adressere jordpakking, erosjon og tap av næringsstoffer (identifisert som de viktigste jordtruslene i området):
1. Redusere jordpakking ved bruk av fangvekster med godt utviklede rotsystemer.
2. Jordforbedrende fangvekster.
3. Presisjonsjordbruk
Disse jordforbedrende tiltakene representerer praksiser med potensielt fordelaktig effekt på jordhelse. Denne studien hadde som viktigste målsetting å formulere alternative retningslinjer for å bidra til og legge til rette for implementering av jordforbedrende tiltak.
Informasjon samlet gjennom blant annet intervjuer og workshoper viser at flere faktorer påvirker i hvilken grad jordforbedrende tiltak blir implementert:
• Økonomiske insentiver
• Mangel på eksplisitte mål for jordhelse i eksisterende lovgivning/jordspesifikk lovgivning
• Liten sammenheng mellom ulik lovgivning
• Mangel på kunnskapsdeling/formidling
• Effekter av klimaendringene
• Leiejord
FANGVEKSTER SOM TILTAK MOT JORDPAKKING OG FOR BEDRET JORDKVALITET
Faktorer som legger til rette for implementering av fangvekster:
• Lengre vekstsesong grunnet klimaendringer
• Negative erfaringer med redusert jordkvalitet som følge av pakkeskader
• Positiv erfaring med fangvekster (rådgivning/gårdsbesøk)
• Fangvekster subsidiert gjennom det regionale miljøprogrammet
• Tilgang til riktig/god informasjon
Barrierer som hindrer opptak av fangvekster:
• Kostnader i forbindelse med kjøp av frø/økonomisk risiko
• Mangel på informasjon om bruk av fangvekster
• Utforming av tilskuddsordninger som begrenser bruken av visse typer frø, metoder og datoer for såing
• Manglende erfaring med bruk av fangvekster under norske forhold
Forfattere
Alicia McNeill, Melanie Muro, Tugce Tugran, Zuzana Lukacova, Alicia McNeill, Melanie Muro, Tugce Tugran, Zuzana Lukacova, Monika Malecka, Winona Vrancken (Milieu), and Kamilla Skaalsveen, Frederik Bøe, Jannes Stolte (NIBIO)
SoilCare
www.soilcare-project.eu

FORDELER OG ULEMPER VED VIRKEMIDLER OG MULIGHETER FOR ØKT IMPLEMENTERING

SoilCare

Det eksisterende politiske rammeverket fremmer allerede jordforbedrende tiltak som testes ut i SoilCare-prosjektet gjennom en rekke eksisterende regulatoriske, økonomiske og frivillige politiske virkemidler og tiltak. Analysen viser at flere økonomiske virkemidler fremmer bruken av fangvekster, en praksis som er relevant for å redusere jordpakking, redusere erosjon og generelt forbedre jordhelsen.

Blå sirkler = jordforbedrende tiltak identifisert som jordhelsefremmende og testet i studieområdet;
Røde sirkler = andre jordforbedrende tiltak fremmet gjennom eksisterende regulatoriske, økonomiske og frivillige politiske virkemidler.

	VEKSTSKIFTE	GRØNNGJØDSLING FANGVEKSTER	INTEGRERT NÆRINGSSTOFF-FORVALTNING	EFFEKTIV IRREGASJON	KONTROLLERT DRENERING	REDUSERT/INGEN JORDARBEIDING	INTEGRERT SKADEDYRS-BEKJEMPELSE	"SMART" UGRAS-HÅNDTERING	PLANTEVERN-HÅNDTERING	KONTROLLERTE KJØRESPOR "SMART"	INTEGRERT LANDSKAPS-FORVALTNING
Forskrift om produksjonstilskudd og avløsertilskudd i jordbruket (FOR-2020-12-21-3044)						●					
Regionale miljøprogram	●	●	●			●					
Forskrift om rammer for Vannforvaltningen (FOR-2006-12-15-1446)		●	●				●				
Forskrift om gjødselvarer mv. av organisk opphav (FOR-2003-07-04-951)		●	●								
Forskrift om Plantevernmidler (FOR-2015-05-06-455)		●					●				

ANBEFALNINGER

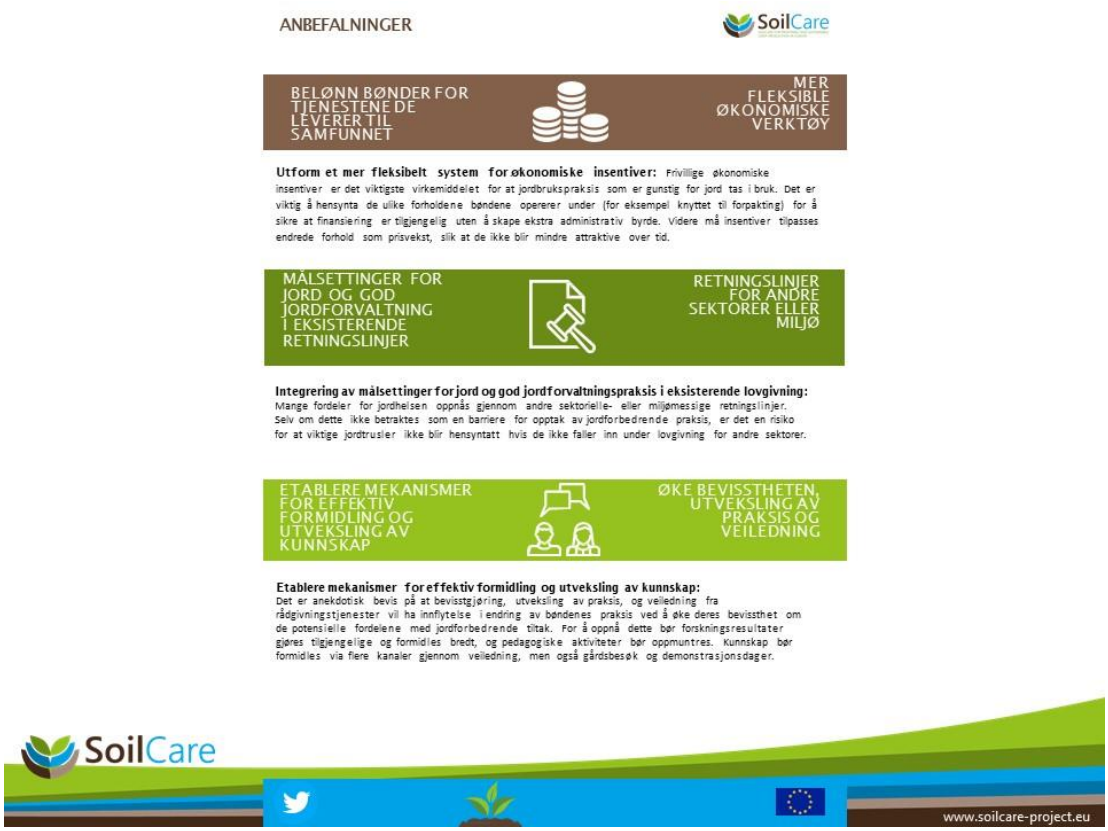
SoilCare

Med utgangspunkt i resultatene fra denne studien, foreslås følgende anbefalinger for retningslinjer:

- REVIDERE DET EKSISTERENDE RAMMEVERKET → AMBISIØSE OG LANGSIKTIGE MÅL
- BELØNN BØNDER FOR TJENESTENE DE LEVERER TIL SAMFUNNET → MER FLEKSIBLE ØKONOMISKE VERKTØY
- MÅLSETTINGER FOR JORD OG GOD JORDFORVALTNING I EKSISTERENDE RETNINGSLINJER → RETNINGSLINJER FOR ANDRE SEKTORER ELLER MILJØ
- ETABLERE MEKANISMER FOR EFFEKTIV FORMIDLING OG UTVEKSLING AV KUNNSKAP → ØKE BEVISSTHETEN, UTVEKSLING AV PRAKSIS OG VEILEDNING

REVIDERE DET EKSISTERENDE RAMMEVERKET → AMBISIØSE OG LANGSIKTIGE MÅL

Revidere det eksisterende politiske rammeverket for å inkludere ambisiøse, langsiktige mål: Enkelte virkemidler, spesielt økonomiske, er viktig for å oppmuntre bønder til å implementere jordforbedrende tiltak. Virkemidler bør tilpasses for å imøtekomme et bredere utvalg av gårdstyper og inkludere mer ambisiøse mål for bedre effekt. I tillegg viser erfaring at endringer i politiske rammer og tilskuddsordninger, som det regionale miljøprogrammet, kan virke som en barriere for gjennomføring. Å sørge for vedvarende finansiering og lovgivningsmessig sikkerhet vil være avgjørende for å motivere bønder til å tilpasse sin praksis.



Appendix 3. An example of how the workshop activities were carried out (although we had some technical issues).


Share
Validering og nytte
Svarer resultatene fra prosjektet til dine forventninger? Hvorfor/hvorfor ikke?
Oppleves resultatene fra prosjektet som nyttige? Spesifiser hvorfor/hvorfor ikke.
SoilCare
www.soilcare-project.eu

POLAND

Report on final stakeholder workshop

Study Site number: 10
Country: Poland
Author(s): Jerzy Lipiec, Bogusław Usowicz, Magdalena Frąc
Affiliation (s): Institute of Agrophysics, Polish Academy of Sciences

Final stakeholder workshop date: 11-03-2021

STRUCTURE FOR FINAL STAKEHOLDER WORKSHOP

1. Introductions - welcoming guests and workshop participants

Because of pandemic situation we organised the on-line workshop via ZOOM platform. Our workshop was completely open via link presented at website of the Institute. However, during our presentations we had hacker attack to our zoom platform and we had to finish workshop and open it again only for few selected people: students, scientists, researchers, PhD students. Therefore finally 19 people participated in the workshop.

2. Presentation of project findings

- Magdalena Frąc – Soil Care for profitable and sustainable crop production in Europe SoilCare – presentation of the project including aims, study site and experiments, main results concerning mycobiome composition and diversity under spent mushroom substrate and chicken manure application, as well as policy activities for soil quality improvement and farmers networks and collaboration and compatibility of the project with other EU projects.
- Jerzy Lipiec - Impact of Soil Improving Cropping Systems (SICS) on plant yielding in sandy soils (2017-2020) – presentation of field experiment and main results obtained within the project, including presentation of factsheet from study site in Poland.
- Bogusław Usowicz – How to assess soil quality and increase yields? – presentation of soil quality definitions, field experiment in study site in Poland and main results concerning soil physical properties.

3. Questions/discussion

During discussion we explained carefully meaning, types and role of soil improving cropping systems. We discussed about policy solutions. Moreover, the participants asked the following questions:

- Will drought affect plant nutrient use from mineral fertilizers and SICS applied?
  (Czy i w jaki sposób susza będzie miała wpływ na wykorzystanie przez rośliny składników odżywczych z nawozów mineralnych?)

  Effects of drought conditions on nutrient uptake by plants is of particular importance in sandy soils that are characterized by a weakly developed aggregated structure, high permeability and low water-retention capacity due to high contribution of large pores (between sand particles) There is a broad consensus that nutrient uptake and plant growth conditions in sandy soils can be improved by increasing organic matter content. Soil organic matter can hold up even 20 times their weight in water and improve the capability of soils to retain and exchange nutrients. Positive effect of soil organic amendments including farmyard manure and legume cover crops in rotation on nutrient supply and crop yield on sandy soils was observed in the field study conducted in the frame of the SoilCare project. Improved nutrient supply was attributed to nutrient inputs from the organic materials and to higher soil water content.
- How can the effects of the SICS applied in terms of soil quality and yield be monitored?
  (W jaki sposób można monitorować skutki stosowanych SICS w kontekście jakości gleb i plonów?)

  Most often used soil quality indicators in response to improving cropping systems include organic matter content, labile carbon content, water holding capacity, plant available water, pH, extractable P, exchangeable Ca, Mg and K, cation exchange capacity (CEC), microbial activity. Responses of crops are monitored by assessing productive tillering coefficient, grain/straw ratio, grain number per spike, thousand grain weight, contents of crude protein, gluten and starch, grain hardness. Our 4-year experiment study with SoilCare project showed that soil organic amendments slightly increased contents of total organic carbon and labile carbon in soil and significantly increased gluten content and decreased hardness of wheat grains
- Which communication channels are best used to implement SICS in production?
  (Jakie kanały komunikacji najlepiej wykorzystać w celu wdrażania SICS do produkcji?)

  SoilCare investigates and promotes the use of Soil-Improving Cropping Systems (SICS) to improve soil quality for positive effects on sustainability and profitability.

The best communication channels that can help in implementation of the SICS can be direct contacts with farmers, discussion with farmers and promotion of SICS inside groups and networks of farmers, demonstration days organised by farmers who implemented SICS solutions in their farms, trainings for advisors specialise in soil health and quality. It is also very important to promote some solutions regionally where they are present and accepted by farmers.

- Why fungi are so important in the research of soil quality? (Dlaczego grzyby są tak ważne w badaniach jakości gleby?)

  Soil fungi are highly diverse organisms. Saprotrophic fungi which can produce a wide range of enzymes allowing the degradation of recalcitrant compounds. Many fungi are strongly linked with plant residue decomposition. Soil fungi can receive substantial quantities of plant derived carbon in the form of root exudates. Arbuscular mycorrhizal fungi (AMF) are obligate symbionts of plant roots. On soils low in P they can be profitable to crops by enhancing nutrient and water uptake. They may also protect plants against pathogens. Soil-borne plant pathogenic fungi cause root disease and thus incite yield losses. The other important group of fungi are endophytic fungi that live inside plant tissues but do not elicit disease symptoms. Fungi participate in soil organic matter decomposition, produce different metabolites, interact with other microorganisms and plants, and therefore its biodiversity can be useful in plant protection, soil quality and health improvement.

Feedback on results (based on summary of questions and discussion after presentations)

- Combination of soil-improving practices compared to single practice caused the higher increase in crop yields and dry gluten content.
- Irrespective of soil-improving practice the crop yields were lower by more than 50% in dry than moist years.
- Soil biodiversity, and especially fungal role is very important in soil quality and sustainable agriculture.
- Networks, including long-term contacts and collaboration with farmers can help SICS implementation.

4. Exercises

Because of our final stakeholder workshop was organised as on-line meeting, in the frame of exercises we prepared questionnaire with the questions proposed in the instruction for workshop preparation. We discussed these questions and then we sent the questionnaire to the participants of our workshop. We received feedback from 8 people.

The following questions were included into the questionnaire:

- Are project results plausible and/or in line with your understanding?
  (Czy wyniki projektu są wiarygodne i/lub zgodne z Państwa oczekiwaniami/przewidywaniami?)
- How could you use results of this project in your work (specify which results can be used in which ways)?
  (W jaki sposób mogłyby zostać wykorzystane wyniki projektu SoilCare w Państwa otoczeniu? Proszę określić, które wyniki można wykorzystać i w jaki sposób.)
- How could we get our findings to more people who can benefit from them (and how you could help)? Provide your name if you offer help
  (W jaki sposób Państwa zdaniem można upowszechnić wyniki projektu większej liczbie osób, które mogą z nich skorzystać? Czy Pan/Pani może w tym pomóc? Jeśli Pan/Pani oferuje swoją pomoc to proszę podać imię i nazwisko oraz adres e-mail.)
- What benefits have you gained from SoilCare already?
  (Jakie korzyści odnieśli Państwo dzięki projektowi SoilCare?)
- How would you like to be supported in using or implementing project/research findings?
  (Jakie byłyby najlepsze formy wsparcia podczas wdrażania wyników projektu/badań?)
- One thing I want to remember with what I learned today. (Proszę wymienić jedną rzecz, o której chce Pan/Pani pamiętać po dzisiejszych warsztatach.)
- One thing I want to do with what I learned today. (Proszę wymienić jedną rzecz, którą chce Pan/Pani zrobić dzięki uczestnictwu w warsztatach SoilCare.)

<u>Feedback on validation and usefulness</u>

- Are project results plausible and/or in line with your understanding?
  a) The project results are credible.
  b) The results of the project are credible, need to be disseminated and reached to audiences to increase plant production in Europe, to maintain competitiveness and sustainable development through soil care.
  c) The presented results are reliable and correspond to the data that can be found in publications and scientific papers on soil quality and soil protection issues.
  d) Yes, the project results are reliable.
  e) For me, the results of the project are reliable, as expected. Each result is properly justified, the results of the conducted research are properly presented both graphically and summarized in text. The influence of e.g. drought on a given yield is also shown.
  f) The results are reliable, the overall results are as predicted, however the effects of some single factors / methods are surprising.
  g) Yes, the results are reliable.

h) Considering that outstanding specialists in the field of agriculture were involved in the SoilCare project, I have no doubts that the works planned and performed under the project are reliable and will serve as guidelines for actions important for the soil quality improvement, thus maintaining its function (soil protection).

- How could you use results of this project in your work (specify which results can be used in which ways)?
  a) The results related to increasing the soil organic carbon content can be exploited using one of the SICS methods to increase the yield.
  b) Farmers in our environment should use soil improving cropping systems, apply crop rotation to improve crop production efficiency and improve soil quality. The use of effective soil-improving cropping systems can be used to demonstrate the positive aspects of these practices to farmers. Dissemination is important to achieve local and European impact by networks and contacts with a wide audience, to increase plant production in Europe, to remain competitive and sustainable development with soil care.
  c) I will use the results which were presented during workshop concerning SICS, especially about the use of spent mushroom substrate and chicken manure, in conversations and discussions with farmers in a close, family environment as an argument for the effectiveness of using organic materials as soil additives in order to improve its quality.
  d) Particularly important are the results concerning the influence of various practices on the populations of soil microorganisms and soil organic matter. The results can be presented to students of e.g. Agriculture, Environmental Protection, and Environmental Bioengineering in order to demonstrate the importance of the role of microorganisms.
  e) In my environment, the results on the yield of cereal grains could be used, I live in the countryside and meet a lot of cereal crops in the fields. The results of the project could encourage local farmers to incorporate presented solutions in their farms, which is environmentally friendly, and important for improvement of soil organic matter. Many farmers do not have cattle, so as solutions presented at the meeting can be useful and implemented, e.g. cover crops. The problem of proper cultivation of the land and agricultural management practices such as soil improving cropping systems can be useful to protect soil against degradation.
  f) As the project is also related to soil microorganisms, the results would be interesting for students. I live in the countryside and I see the problem that farmers are not aware about soil processes. The project results and the lectures presented are a good example for understanding of importance of soil quality and processes.
  g) Taking into account the fact that my parents are involved in agriculture, I think it would be useful to use the knowledge during workshop to improve yield of crops based on Soil improving cropping systems incorporation into the farm.

h) The use of chicken manure and spent mushroom substrate in the apple / pear orchard in the Horticulture Farm of my brother, who expressed interest in such activities.

<u>Suggestions and offers of help to further disseminate findings</u>

- How could we get our findings to more people who can benefit from them (and how you could help)? Provide your name if you offer help
  a) The results of the project can be disseminated by contacts with agricultural advisors all over Poland, as well as by organizing events for farmers where it will be possible to present this project results.
  b) The results of the SoilCare project should be disseminated.
  c) The results can be disseminated by sending information leaflets to farmers, organizing educational meetings and by making short information / educational videos available on the Internet (social networks, etc.)
  d) I will be happy to present the results during classes with students.
  e) The results of the project can be disseminated as it was shown to students, young generations. However, I think that it is worth that the slightly older generation should also have such awareness. I do not know if this idea is good, but maybe organizing meetings in a given commune, in regions that are more economic, would be justified.
  f) In my opinion, conducting a presentation of the project and results for a larger number of students who can inspire / become interested in the project results. Also cooperation with local institutions / organizations. Presentation of film on this subject/project results, e.g. on the YouTube platform. I am a student of environmental protection, and therefore the soil quality is very important to me. The project is very interesting. I will gladly take part in spreading such important information in the future.
  g) I think that an idea worth considering is establishing cooperation with individual agricultural communes. Providing information with both printed materials containing advices on soil improving cropping systems and links to the website with practical advices. It may also be worth considering conducting stationary training for farmers at the powiat level.
  h) By establishing contact / cooperation with agricultural advisors, so that they provide information about the project assumptions, performed works and project results to farmers as part of their advisory activities.
  i) By leaving leaflets informing about the project and its results at points of sale of plant protection products / fertilizers / agricultural equipment.
  j) Via social networks in Polish e.g. Facebook.

SoilCare impacts to date

- What benefits have you gained from SoilCare already?
  a) I gained new knowledge that I will use in the future.
  b) Thanks to the participation in the workshops, I learned how important the soil quality is for us and how important is a dissemination among farmers.
  c) Learn about SICS and the possible impact on the soil environment, get new contacts with experts in agriculture and soil quality
  d) The content that I present during classes with students has been supported by specific results presented during the workshops. Thanks to the workshops, the classes are more credible and interesting.
  e) Benefits, certainly new knowledge, a good explanation of each of the topics discussed, an illustration of what the SoilCare project is and its benefits.
  f) Identification of the problem and specific actions taking for soil quality improvement.
  g) By attending the SoilCare workshop and visiting the project website, I was able to find out which farming systems improve soil quality.
  h) Broadening the knowledge of SICS, the impact of agricultural treatments on soil quality.
  i) Knowledge about the composition of the soil mycobiome as a result of long-term use of spent substrate mushroom and chicken manure.
  j) Experience of cooperation in an international project of high importance.

Plans/aspirations for future impact

- How would you like to be supported in using or implementing project/research findings?
  a) The best form of support would be financial support.
  b) The best support during the implementation of research results is evidence of their effects in practice (credibility).
  c) Merit support for farmers, what activities and how they should implement, providing precise advices and providing information on the effectiveness of actions taken.
  d) Financial support, meetings with farmers, videos.
  e) Perhaps some financial subsidies.
  f) Certainly, a good form of support for the implementation of research results would be cooperation with companies dealing with modern technologies in agriculture.
  g) Ministerial subsidies.

- One thing I want to remember with what I learned today.
  a) Using few SICS together gives the best results.

b) Plant diversity and activity.
c) SICS strategy.
d) It is very important to take actions that support the biodiversity of soil microorganisms.
e) That it is important to remember about our Planet and environment. Without being aware, we will take what is most valuable to the Planet, and precise indication of specific methods, including SICS will allow us to protect environment. The fungi play very important role in the soil.
f) I will remember that enrichment of the soil with organic carbon is very important for soil quality.
g) After SoilCare workshop, I want to remember that an important part of life is taking care of the soil quality.
h) SICS.

- One thing I want to do with what I learned today.
  a) I want to talk about the results of the project.
  b) I want to help disseminate research results from the SoilCare project.
  c) Communicate the acquired information on SICS to those directly interested in the implementation.
  d) Share information and insights with students of other faculties.
  e) Expand knowledge about active soil protection and its biological reconstruction.
  f) Thanks to participation in the workshops, I want to share the information collected during the project with people who deal with agriculture, to increase their awareness and use this valuable knowledge in practice.
  g) Further promote the importance of soil protection in sustainable plant production.

PORTUGAL

SoilCare
SOILCARE FOR PROFITABLE AND SUSTAINABLE CROP PRODUCTION IN EUROPE

WP3

Final Workshop - WEBINAR

Final Report

26 of March of 2021

ESAC
"Agricultural High school of Coimbra"

António Dinis Ferreira
Anne Karine Boulet

1. Introduction

The final workshop of the SoilCare project was organized online as an open webinar on the 26 of March in the Colibri_Zoom platform from 10h to 12h.
(https://videoconf-colibri.zoom.us/j/84324977746?pwd=ZlZSaTIxWFJXOTA5NjVLcUpHRm9rdz09).
Divulgation have been made through various institution (ESAC, DRAP, Agriculture association, and local press).

Figure 1 : Divulgation via FB at the ESAC page

Figure 2 : Program of the webinar

The number of participants was about 50 peoples online.

The results presentation was realized by the way of 5 powerpoint presentations: two presentations per SICS (except for “Organic amendment with sludge” SICS, the farmer explained his activity online without digital support powerpoint).

For the first 2 presentations, the introduction was realized by technician’s expert on the topic, Carlos Alarcão from the DRAP for the “Legumes green manure” SICS, Antonio Jordão from the DRAP for the “Organic rice in rotation with Lucerne” SICS and the last one, the “Organic amendment with sludge” SICS by a Farmer, João Ferreira, that use that technique and owner of the field where the trial field were realized. Following each introduction, Anne-Karine Boulet from the ESAC presented a syntheses of the results obtained in term of physical, chemical and biological soil parameters evolution as well as an economic balance analyses. (See program and powerpoint presentations in annex).

As it was not possible to realize the post-it exercises due to the virtual presence of the public, a link for questionnaire online in google form had been make available for the participants at the end of the presentation part.

Figure 3: Questionnaire (google form) available online for the participant at the end of the webinar

At the end of the presentation, it was given time for questions and debate. Some participants asked for technical precisions, or commented the results orally or in the chat. The feedback of the participant was always very positive.

2. Principal results

SICS – Organic Rice in rotation with lucerne

Overall results of this study show that:

- The SICS improves soil fertility in term of soil organic matter content with all the benefits link to increase of SOM in soils. It maintains macro nutrient pool in the medium class of soil analyse interpretation, with a very low mineral fertilization reduced to Phosphorus input.
- The SICS that avoid any mineral nitrogen fertilization is a very conservative technic in term of nutrient leaching. It encourages the accumulation of Nitrogen in the soil using the Nitrogen biological fixation capacity of the Lucerne. This nitrogen will be uptake by the rice after 2 years of Lucerne cultivation reducing drastically the risk of leaching and the pollution of the groundwater.

- The choice of a cultivar of rice (arroz carolino: ariete and allório) with reduce nutrient requirements, allows to attain the expected yield and preserve grain qualities for the variety with a low input of mineral fertilizer. These cultivars with high tasty qualities are very appreciated in the region it exists a high demand. Combined with organic mode of production it would be very interesting to improve this cultivar agronomically, to organize their commercialization (for example no separate infrastructure exist yet for peeling and drying organic rice at the agricultural cooperative) and promote the sell in order to develop and valorise the production to attain a sustainable amount of production in the region. It already exists in the baixo Mondego region an IGP Indicação Geográfica Protegida (protected geographic indication) for the conventional arroz Carolino do Baixo Mondego.
- Weed control is currently a major issue for rice cultivation. Weed resistance to herbicides is increasing every year as the number of active molecules available for treatment become always fewer with the increasing severity of the phytosanitary legislation. The SICS allows to maintain the weed infection rate in a proportion that will not affect the corn yield. The blind seeding is an efficient technique very easy to implement with reduce cost (only soil mobilization cost) avoiding the use of herbicide at the emergence phase. The manual weed control used for the SICS is an extremely workload technique and difficult to implement for large area. Nevertheless, due to the low cost of human labour in Portugal, and the very high cost of pesticides, the saved money in pesticide would be equivalent to 100 hours of human labour per ha, corresponding to the workload necessary for manual weed control. The introduction of perennial lucerne in the production system, with a high capacity of biomass production is very efficient in term of weed control and permit to decrease drastically the weed emergence during the growing period. Nevertheless, the positive effect in seed bank reduction for the rice production is limited by the fact that weeds infecting rice (able to grow in flooded areas as wild rice) are different from the weeds infecting the Lucerne, but even so it allows to decrease significantly the weed pressure on the rice cultivation. A second problem to be solve would be the lack of human workload for seasonal service, but also not impossible to solve. This issue is a key technical question for organic rice

management and need to be investigated. Some techniques have been already tested as rice seeding in line combined with biodegradable mulch film applied to soil surface and limiting the weed infection or dry seeding technique in line, with mechanical hoeing or the planting of young plants of rice in tillering phase combined with blind seeding or mechanical hoeing… but until now none of them gave satisfactory results.

In conclusion, the SICS tested in this study reveal to be more sustainable in term of environmental and economic issues that the Control with a i) slight increase of the SOM content with all the benefits due to this improvement in soil quality, ii) decrease of use of mineral fertilizers, especially of nitrogen, mitigating the risk of nutrient leaching and groundwater pollution, iii) no use of pesticides leading to mitigate soil air and water pollution, improve biodiversity, and protect animal and human health; iv) improvement of the framer net income.

It exists some conditioners i) an increase of the weeds control problem leading to the need of high amount of human labour for a specific period; ii) a problem of rice processing and commercialization due to the inexistence of organic rice sector in the region.

The organic rice production in rotation with Lucerne is a sustainable SICS that deserve to be promoted and develop by the farmer associations and organizations with the ambit to trial innovative methods for weed control and guarantee to the farmers the processing and commercialization of their production in rice or lucerne hay.

In term of market, it exists an emergent market for high quality and differentiated products. Farmers must learn to communicate better and to value the quality of their products, in order to sell the product at a fair price that compensates the effort and turn them independent from subsidies.

Market niches have to be organized in cooperation with cooperatives, or producer associations. The quality of the product (bio rice and lucerne hay) must be evidenced with the choice of differentiated bio rice varieties, with specified characteristics, in order to bet on a high price, justified by the quality. It could be also a long-term strategy

to promote the region, for example through the development of IGP certification - Protected Geographical Indication.

SICS – Organic amendment with urban sludge

- After 3 consecutive years of urban sludge application in the agricultural field, the SICS improved significantly soil fertility, almost all the parameters analyses in this study show a positive impact of the urban sludge application. It improved pH, SOC content, Total Nitrogen, Available Phosphorus and Potassium, exchangeable cations (Ca2+ and K+) and also Earthworms density. Nevertheless, the SICS soil analyses highlight values extremely high of Phosphorus and Potassium, especially of Phosphorus, indicating a disequilibrium in the soil probably driven by an over complementary mineral fertilization, that can lead to the leaching of the excess of nutrients and the pollution of the groundwater. A special attention has to be pay to the adjustment of the mineral fertilization in function of the nutrients contained in the sludge. Even if the complementary fertilization doses recommendations are provided by the sludge operator in function of the nutrient composition of the sludge spread in the field, farmers have tendency to apply higher quantity of mineral fertilizer than necessary to avoid any risk of crop yield lost. It is then important to make aware the farmer to the risk of nutrient leaching and soil/water pollution relative to the excessive application of fertilizer.
- In relation with the polemic topic of heavy metal accumulation in the soil, this study doesn't show any relevant increase of heavy metal concentration in the soil. The concentrations maintain much lower that the limits defined by the national law for sludge application or fertilizer application in general.
- The SICS shows also an increase of 37% in term of financial benefit, corresponding to a gain of about 300 euros per year compared to the Control. This improvement in term of net income can be attribute mainly to the reduction in mineral amendment (especially in Nitrogen and Phosphorus) allowed by the large amount of nutrient contained in the urban sludge.

- The most problematic part of the SICS is the socio-cultural part. The SICS required an extra work that correspond to a pic of activity in the seeding period that can be difficult to manage. It also can delay the seeding in case of bad meteorological conditions that exclude the sludge application.
- The approval of a sludge management plan by various entities that is a lengthy and tedious administrative process that discourage many farmers to use this technique. A simplification of the administrative procedures (but not of the environmental and application norms) could encourage the farmers to use this technique.
- In term of perceived risks and farmer reputation, the agricultural valorization of sludge is perceived very badly by the population in general and also the farmers constituting a great barrier to its implementation and acceptance. The dissemination of study results on the environmental impact of sludge in seminars or dissemination to the general public, would demystify the use of sludge, explaining that risks are controlled through the sludge management plan
- One solution would be the reduction of the smell that is technically possible by stabilization of the organic matter, through digestion, dehydration, or by composting. But these techniques have a high cost and could be implemented in a larger scale if farmers start paying for agricultural valorization of the sludge (free of cost until now), in order to participate to the sludge treatment costs.

SICS – Legume winter cover crop used as green manure

The substitution of the winter fallow by the sown of winter legume cover crop is a SICS adapted to the Mediterranean conditions and even if doesn't show an increase in Soil fertility, provides interesting advantage in term of environmental sustainability.

LCC produce high amounts of biomass far above the quantities registered for most of the studies developed in colder climate, as they survive to the winter and presented an important growing phase in spring before to be cut. The clover species even if the reduce size of their seeds that turn the installation more delicate (obliging to a finer

preparation of the seeds bed) and a very slow start-up of the growing phase, presented a final biomass production much higher that forage pea or yellow lupin even if the initial growing phase of this 2 species is earlier and quicker. This fact leads to potential best performance of the forage pea and yellow lupin (and also crimson clover that is the most precocious of the clovers) in term of nutrient leaching mitigation that occurred mostly during the autumn season for the first rainfall events after the summer. Nevertheless, it is important to notice that no pesticides have been used for legumes cultivation, then at the initial growing phase, the percentage of weed infection is extremely high. It implies that a large part of the initial mitigation of the nutrient leaching is provide by the weed and not by the legumes. Considering the entire vegetative period, legumes allow an important uptake of nutrients from the soil, contributing to mitigate the loss of nutrients, but majority during spring period, and not during the critical period in term of nutrient leaching. That lead to put in light the importance of the seeding date that have to be the sooner as possible in order to avail the last weeks of soft temperatures allowing a rapid installation of the legumes and an optimization of the nutrient immobilization by the legumes.

In term of green manure services, it is important to divulgate these results and deliver to the farmers simples tools, allowing them to estimate the amount of nutrients that various species of legumes are able to provide in which conditions and the corresponding amount of mineral fertilizer that they could save.

This study also highlight for an expected grain corn yield of 12t/ha, grown in good soil fertility conditions, that it is possible theoretically to reduce the amount of NPK mineral fertilizer of respectively (40, 60 and 100% corresponding to saving 100, 30 and 50 kg/ha of N, P2O5, K2O) on account of the nutrient recycling provided by green manure incorporation. It is interesting to note that the second year of the project, it was obtained a maize yield of 11 ton/ha, with a mineral fertilization NPK rate extremely low (100-0-0) indicated that the quantity of nutrients effectively available for the corn growth were higher than the expected following our calculations and estimations (the

organic matter degradation velocity and rate being extremely difficult to estimate). This express the need to test various quantity of mineral fertilization in order to determine empirically the optimal rate of fertilization in order to maintain the level of production and limits loss nutrients.

The study of the effect of some environmental conditions cannot be planed, just be observed when happened and needs various consecutive years of study to cover a vast set of conditions. For example, it was possible to determine during the second year of the study that presented a very wet winter, that some species were more resistant to pounding that others, like yellow lupin or crimson clover, what is an important factor in a region where terrain are frequently immerses. The effect of the freeze should be possible to evaluate for the 3rd campaign in course that presented 2 weeks of negative temperatures in January.

In conclusion, the Legume Cover Crop species (treatments) showed good adaptation to the regional conditions, producing high amounts of dry matter especially in the case of clover species, which reached yields of up to 8 ton/ha for good soil fertility conditions. Nevertheless the variability of the result inter and intra species is very high due to the influence of many parameters, like precipitation amount and intensity leaving to soil pounding, and lethality of the plants or spatial variability of soil fertility, or the sowing date more or less precocious, the cutting date…

LCC incorporation into the soil had no clear effect in terms soil properties, except a decrease seasonal variation pattern of the SOM and a slight decrease in time. The fallow control plot does not suffer such seasonal variation that may reflect important modifications in soil nutrient cycles due to incorporation of LCC biomass with high decomposition potential.

Uptake of macronutrients by the LCC was extremely high (medium NPK uptake 176-20-172 kg/ha), due to their generally high biomass production, highlighting high potential

for mitigating nutrient leaching mitigation. However, it is very important to adjust the sowing date to the critical rainfall period and perform early seeding to maximize nutrient uptake by cover crops.

The capacity of LCC to provide green manure services enabled a general reduction of at least 40% of N, 30% of P, and 100% of K supplied by mineral fertilizers. The quick release of nutrients by the LCC incorporated into the soil (generally after 0-3 months) shows that legumes are a useful cover crop before a grain corn crop.

Use of LCC was also important for weed control, although only in the second year of the experiment. Three clover species (crimson, balansa, and arrowleaf clover) performed best in terms of weed control (0.5 ton/ha, compared with 3-4 ton/ha in the control plot), due to early establishment and/or high biomass production in later growth stages, ensuring strong competition with weed species.

In general, clover species performed best in the provision of agro-ecological services, in particular arrowleaf, balansa, and crimson clover. Future studies should investigate the long-term impacts of LCC on soil fertility and weed control, and thus their contribution to sustainable agriculture systems.

In term of sociocultural aspects, the SICS increase the need of workload during pics and also presented risk of failure of the legume cover crop cultivation due to the climatic conditions, but is commonly very well perceived by the community and increase positively the reputation of the farmer. It also has a small positive economic impact on the net income of the farmer.

3. Results of the Questionnaire

There was a problem with the questionnaire. The link that has been make available for the participants at the end of the webinar, by mistake was copied as editable version and stay completely unformatted after the first people fill it. When we realized the

problem, we corrected the formulary and made it online again, but almost all the participants had already left the virtual room.

Then we sent by email the questionnaire, but as it was an open webinar, we do not have the email address of all the participants. That is why we failed with the aspect in reporting the usefulness, benefits, and divulgation of the result for the participants. We will join an annex to this report later in order to include as in these of the emails answer, but that will be made out of the deadline for this report.

Annexure 1

On the base of the discussion with the stakeholders that was very interested in the current results of the 3 SICS it was decided to maintain the sampling campaign (in term of soil/vegetation) for at least more 2 years as evolution of soil quality are very slow and we would like to improve our data set in order to observe and validate the results.

Concerning the SICS 1 (organic rice in rotation with Lucerne)
as the weed control was one of the major issue, it was planned to propose for the next year master thesis subject at the ESAC about the subject.

Concerning the SICS 2 (organic amendment with urban sludge)
It was decided to continue the soil sampling campaign in the SoilCare study sites, and eventually think about in collaboration with sludge operators make a survey (with soil sampling campaign) of the global situation in the Baixo Vouga valley.

Following the SoilCare dissemination initiatives, the researchers were approached by two companies belonging to the same economic Group – Grupo NOV, namely the BioEnergias and Biosmart, with two propositions to work together.

With BioEnergias, it was decided to create a network of experts contacts and organized two online meetings to discuss and celebrate the creation a working group on urban sludge valorization.
This working group included the following people:
- [redacted] of the Bionergias Company, sludge operator)
- [redacted] (representative of the DRAPC and expert on effluent management)
- [redacted] (Director of ESAC soil Laboratory - Master on Sludge valorization)
- [redacted] (Professor at the ESAC, Soil Fertility and Plant Nutrition)

- [redacted] (Professor ESAC, Soil Science, Agricultural Plant Science and Agronomy)
- [redacted] (Professor at the ESAC, Circular Economy)
- [redacted] (Researcher ESAC, soil fertility)

The overall objective of this work group was exploring the hypothesis of writing a technical manual to frame the use of treated wastewater sludge in agriculture and to disseminate knowledge and also clear and concise fact sheets online in order to undemonize the use of urban sludge, and give clear and objective information about it use in order to improve circular economy and soil quality. It also aims to prepare proposals for new research and dissemination projects on urban sludge valorization.

With Biosmart Company, it was also created a network of experts that will manage the project to test various solutions to process wastewater from pig farms and dairy farms. It was organized on June a first video conference Zoom with 9 participants from the Biosmart company and the ESAC with the following meeting themes:

1. Opening of the TESB project - Pig and Bovine Effluent Treatment:
1.1. Scope of the project: contextualization of the objectives of Biosmart
2. Definition of the project team:
    2.1: Biosmart: [redacted]
    2.2: ESAC: [redacted]
    2.3: Pig farming: [redacted]
    2.4: Cattle Raising: [redacted]
3. Presentation of the solutions to be studied
4. Reproduction of the laboratory conditions of the solutions to be studied: study to be carried out by ESAC

Creation of a working group on urban sludge valorization

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[redacted] (representant of the DRAPC and expert on effluent management)
[redacted] ([redacted] ESAC soil Laboratory - Master on Sludge valorization)
- Daniela Santos (Professor at the ESAC, Soil Fertility and Plant Nutrition)

[redacted] (Professor ESAC, Soil Science, Agricultural Plant Science and Agronomy)
[redacted] (Professor at the ESAC, Circular Economy)
[redacted] (Researcher ESAC, soil fertility)

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    2.1: Biosmart: [redacted]
    2.2: ESAC: [redacted]
    2.3: Pig farming: [redacted]
    2.4: Cattle Raising: [redacted]
3. Presentation of the solutions to be studied
4. Reproduction of the laboratory conditions of the solutions to be studied: study to be carried out by ESAC

Concerning the SICS 3 (legume winter cover crop used as green manure), it was decided to continue the monitoring of the field in the next 2 years in order to observe the long term evolution of the soil quality, but also to describe the agronomic behaviour of the 6 species of leguminous for a large set of climatic conditions as inter-annual variability was very high.
And also organize more open days at the legumes flowering season (with the hope that Covid-19 will turn in the future just a bad memory) that is one of the best tool of SICS dissemination in our opinion.

A problem that was identified by one of the stakeholder (seed distributor) was the high price of the cover crop seeds (legumes) and the scarcity of national seed multiplication and diversification. It was evocating the hypotheses to create a think tank to find new project ideas to solve this limitation. But until now nothing concrete have been done.

The seed distributor company also will publish in its company website the results of the SoilCare experiments.

In a general ways, experiment fact sheets will be published at the school webpage and will also be online at the technical divulgation page of the DRAPC “Regional Directorate of Agriculture and Fisheries” (DRAP-Centro) and “Portuguese Environment Agency” (APA - ARH Centro). We hope that they also will be also published in the AGROTEC magazine that is a reference in Portugal in term of Technical Agricultural information.

Annexure 2

RESPONSES TO THE QUESTIONNAIRE ONLINE

Institution

DRAPCentro
Instituto Politécnico de Coimbra / IIA / CERNAS
ABOFH Baixo Mondego
DRAPCentro
ESAC
NUTRIPRADO LDA
IPC/Escola Superior Agrária de Coimbra

E.mail

[redacted]@drapc.min-agricultura.pt
[redacted]@gmail.com
[redacted]@gmail.com
[redacted]@drapc.gov.pt
[redacted]@esac.pt
[redacted]@nutriprado.com
[redacted]@esac.pt

Have you participated in any of the previous SoilCare workshops?

Sim 85,7%
Não 14,3%

Are the results of the project plausible and / or are they in agreement with your understanding?

Sim 100%
Não 0%

If you answered no to the previous question, describe in what ways

XXX

How could you use the results of this project in your work (specify which results can be used and in what ways)?

For the dissemination of knowledge and learning
The results are interesting and can serve as a basis for future research.
NS/NR
Dissemination and technical support to the economic agents of the sector and in agrarian higher education
Especially those related to the use of legumes as excellent auxiliaries for more environmentally friendly agriculture.
For the rotation of the cultures and which varieties could be used in technical advice.
The results can be shared in training actions for technicians related to the agricultural valorization of sludge

How can we disseminate the knowledge acquired through the SoilCare project so that it could benefit more people (how could you help)?

Through the national rural network RRN

Publication of the work in national and international scientific journals

Advertising by institutions and on social networks
transmitting information to technicians, farmers and students of agricultural professional education and agrarian higher education
At the local / regional level using institutions and other living forces to help their dissemination in the most appropriate and desirable forms for each one.
Publish on my website and promote to costumers
Disclosure by producers and operators of agricultural sludge valorization, technicians from companies, associations and cooperatives that request analyses for the assessment of soil fertility.

What benefits have you gained from SoilCare?

Knowledge about soil fertility
Deepening of knowledge about the impact of management practices on soil quality.
NS/NR

Information and consolidation of technical knowledge

Increased knowledge and exchange of divergent experiences.
Knowledge and results.
Sharing knowledge and resources

Como gostaria de ser apoiado no uso ou implementação dos resultados de projetos / investigação?

The difficulties presented in the biological production of rice and the need to be more tested the techniques of incorporating legumes in the soil to increase its fertility, since there are many variables that interfere in this process.
With the discussion of technical knowledge.
NS/NR

Participation in actions to share scientific and technical knowledge and specialized agronomic training.
I'm sorry: I didn't understand the question!

Divulgation

I would like to participate in the evaluation / treatment of analytical results and discussion to clearly understand the effect of the application of sludge on the soil-plant system, at the agronomic level and potential polluting effects and with reference to the legislation in force.

Citar uma coisa que queria lembrar ou uma coisa que queria fazer com o que aprendeu hoje

The application of sludge has an interesting potential.
It is necessary to increase the organic matter of the soil, which is the food of the soil itself
Recalling the need to extend the tests to the whole of the Mondego Valley so that their coverage is complete, complete and representative of the different soil and climatic conditions so that the results can be cherished and followed by local users.
Take care of the soil it is unique

We appreciate your participation in this survey...

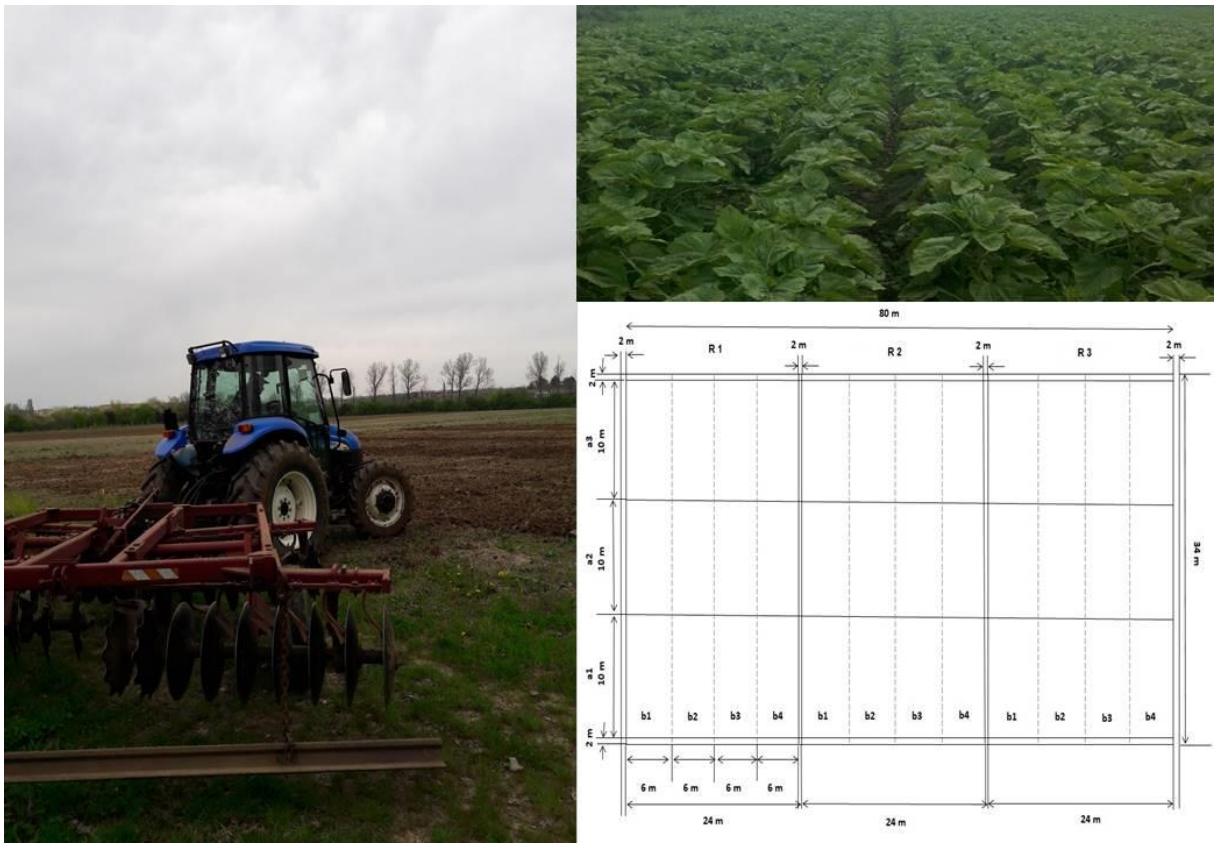
ROMANIA

CSS 08 – Draganesti-Vlasca (Romania)

Report on Final Stakeholder Workshop

Author(s): Irina Calciu, Olga Vizitu
Affiliation: ICPA Bucharest

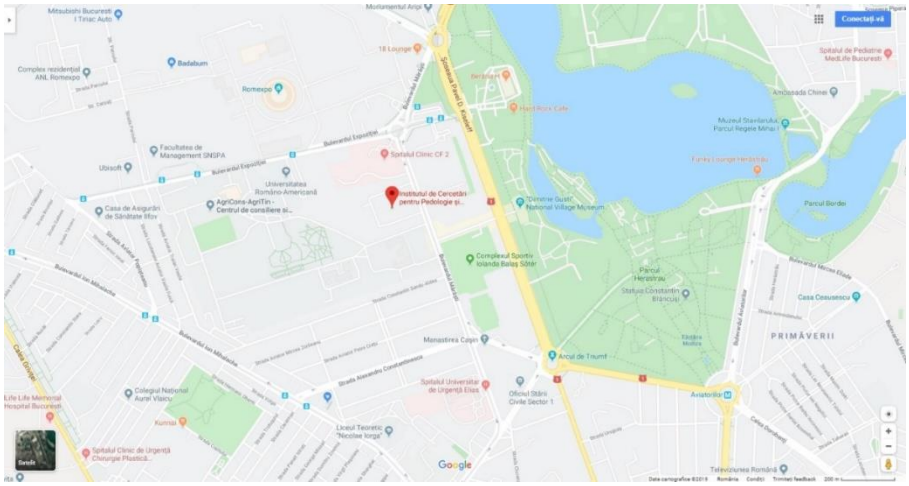
Experiment: Soil tillage effects on soil quality



Date: 11-05-2021

Introduction

On 20th of April 2021, at the ICPA institute's headquarter, the final workshop for stakeholder analysis of the selected SICS (Soil Improving Cropping Systems) was held.



Participants

At the event 13 people attended (5 women and 8 men), out of 30 people invited. People were invited by direct invitation and telephone calls, made to 2-3 people from each group of interested stakeholders (research, agricultural research and development stations, high school and university education, trade agricultural research unionists, local public authority, advisory service, land managers, farmers and farmers' association).

Scope of the workshop and agenda

The workshop was organized between the study site research team and invited participants and lasted for 3.5 hours. The scope was to disseminate the project results among the stakeholders involved in the SoilCare project and to make an analysis of the tested SICS within the study site.

The workshop agenda contained the following:

- SoilCare project objectives presentation;
- description of the tested SICS;
- presentation of results for the measured soil variables of the tested SICS;
- stakeholder analysis of the SICS;
- main important findings;
- stakeholder analysis conclusions.

After the SoilCare project objectives presentation, the ICPA research team involved within the project described the experiment conducted in Draganesti-Vlasca study site area.
Later, time was allocated for the stakeholders to analyze the results obtained for the tested SICS.

At the end of the workshop, conclusions about stakeholder analysis were drawn by hosts together with the participants after analyzing the tested SICS within the study area.

Description of the tested SICS

The main objective of the experiment was to evaluate the effect of 4 different tillage practices (3 SICS variants and 1 control variant) in order to mitigate soil compaction under three different crop rotation schemes which included legumes and cereals. The experiment was established in March 2018 and was set up in a split plot-randomized complete block design with 3 main plots, one for each crop rotation scheme and 3 blocks, containing 12 plots each. In each block there were a combination of 3 different rotations and 4 tillage practices.
The treatments are combinations of level from the two factors: tillage and crop rotation.

- The tillage levels included: mouldboard ploughing with furrow inversion at 25 cm depth, subsoiling at 60 cm, disking at 12 cm depth (control variant) and chiselling at 25 cm depth without furrow inversion.
- The three different rotations mentioned were:

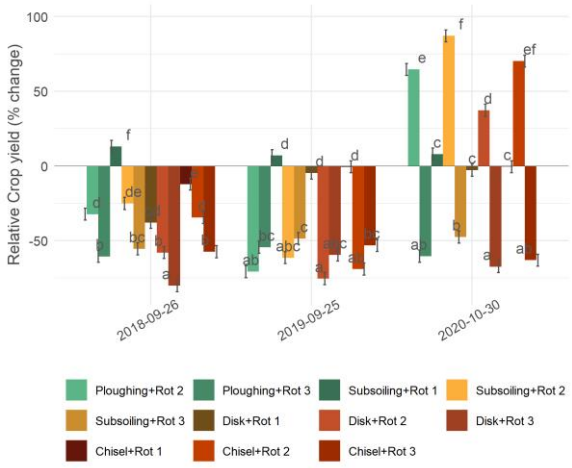
  Rotation 1: Maize – Soybean – Barley;
  Rotation 2: Winter wheat – Mustard – Sunflower;
  Rotation 3: Spring barley – Maize – Soybean.

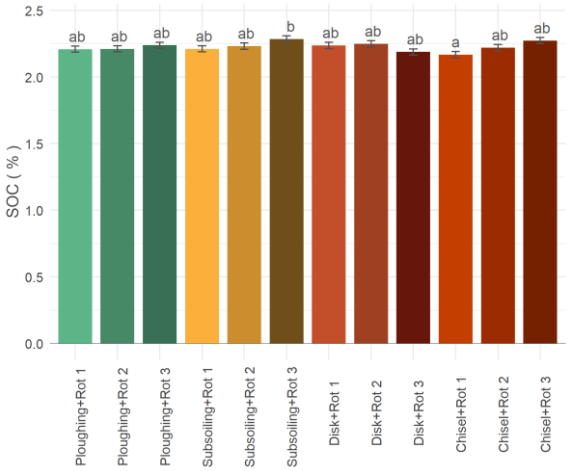
Field operations: The experimental field was fertilized every spring with a complex fertilizer NPK 15:15:15 and also 2 kg/ha Glyphosate was applied during May.

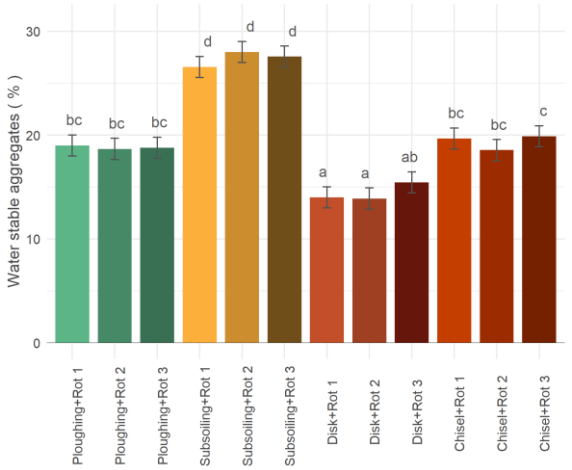
Presentation of results for the measured soil variables of the tested SICS

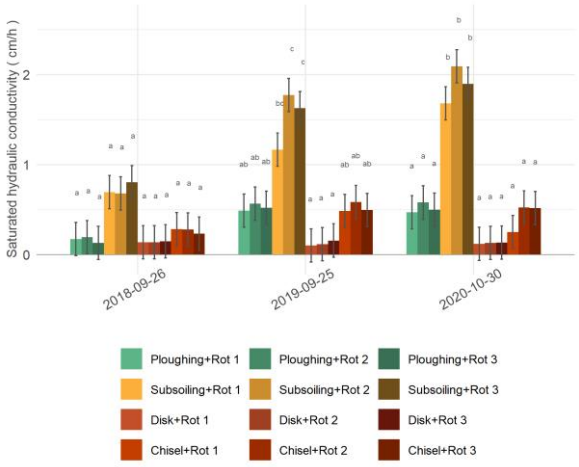
The variables measured and analysed for this experiment conducted in Draganesti-Vlasca study area were: saturated hydraulic conductivity; water contents at Field Capacity, Wilting Point, pF 2.7, pF 1.08; water stable aggregates; bulk density in topsoil and subsoil; soil texture; available phosphorus; exchangeable potassium; soil organic carbon content; soil pH; electrical conductivity; crop yield.
Next, some obtained results were presented for this experimental site. This was done for the stakeholders in order to determine which one is the most suitable to mitigate the soil threat in the area and, at the same time, to have financial benefits for farmers without further degradation of soil quality.

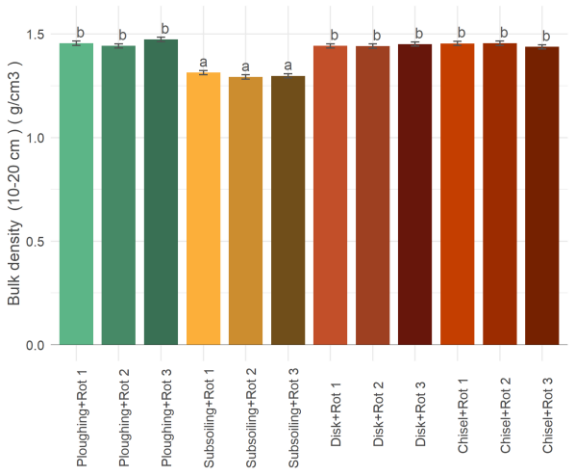
Below, the figures of some of the variables measured for this experimental site were presented to the stakeholders. These variables were: the relative crop yield, soil organic carbon content (SOC), water stable aggregates, saturated hydraulic conductivity and bulk density for both topsoil and subsoil.

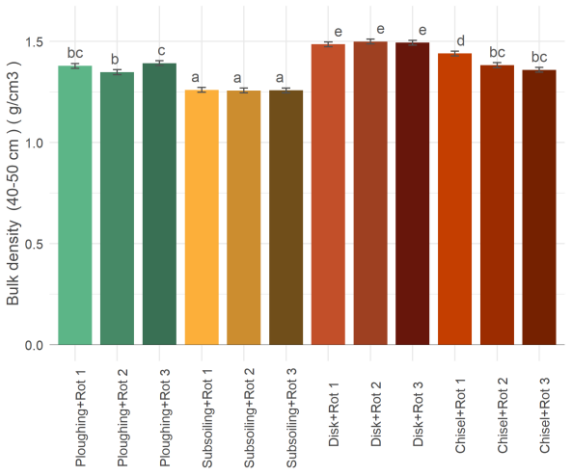












Stakeholders analysis of the SICS

Presentation of the results

Later, the project research team made an overall analysis of the main findings and presented them to the workshop participants. These findings are summarized in the paragraphs below. The soil from the study was characterized in terms of hydro-physical and chemical properties. The soil type was a Cambic Chernozem with clay loam texture. These high contents in clay resulted in higher values for bulk density within the soil profile. The bulk density values in the topsoil were higher in plots where ploughing, disking and chiselling were done, while in variant where subsoiling was performed the values were lower. The same trend was observed also in case of measured bulk densities values in the subsoil.

The soil from the study site is susceptible to degradation by natural subsoil compaction. Degradation of soils due to compaction is a worldwide problem, and the problems caused by this may be: a decreased root length, retarded root penetration and shallower rooting depth. The soil compaction can result in greater concentration of roots in upper soil layer and reduced root growth in deeper soil layer, mostly due to excessive mechanical impedance such as hard pan which is formed below the tillage depth.

Soil structure represents one of the major attributes of soil quality and it affects the soil pore system and through it the water movement processes in soil, which was measured by saturated hydraulic conductivity. The saturated hydraulic conductivity of such fine textured soil shows a high variability and records low values, the most significant decrease being encountered in control variant where disking tillage was done. Also the saturated hydraulic conductivity values were highly variable between both treatments and three experimental years. The highest values of saturated hydraulic conductivity were determined in variants where subsoiling tillage was done. Moreover, in the plots with subsoiling tillage, the saturated hydraulic conductivity values increased from year to year, meaning that the soil porous system continuity was not further disturbed by tillage and the water pathways in soil were not interrupted.

Soil porosity plays a significant role in evaluation of the impact of management practices on the quality of soil structure. By adopting alternative tillage systems, such as subsoiling tillage treatment, the soil macro-porosity increased and was more-homogeneously distributed through the profile when compared with a disking tillage variant, and the resulting soil structure has a better quality, as was confirmed by the higher hydraulic conductivity measured in the soil tilled by subsoiling. This was confirmed also by the values measured for water stable aggregates, which were higher in the treatment with subsoiling tillage for all 3 investigated years.

The tested SICS treatments within the experimental field showed a high variability regarding the plant crops yields. In general, the treatment where subsoiling was applied led to production increases, while the treatments where disking and chiselling were done led to production

decreases. The level of yields obtained in treatment where mouldboard ploughing was done ranged between those obtained in plots where subsoiling and chiselling tillage was done.
Regarding the chemical characterization of the studied soil, there were not significant variations between the applied treatments and also between the 3 analysed years. The soil reaction values in case of all treatments highlighted a lightly acid soil.
The soil organic carbon content didn't vary between the applied treatments, the content being moderate within all 3 experimental years. The investigated soil was highly supplied with available phosphorus, while for the potassium content the soil was low to moderately supplied.

Stakeholders analysis
Since the impact of tested SICS depended on various factors such as local weather, socio-economic conditions, the stakeholder analysis took into account the local specific conditions and the information provided by them. Then, each tested SICS was analysed from the drawbacks and benefits point of view.

Mouldboard ploughing SICS: stakeholders decided that by using high levels of chemical inputs there may increase the health risk due to nutrients leaching and infiltration in groundwater table. In dry years, there is a potential risk of crop failure because of the water stress for crops during the growing season. On the contrary, if the ploughing tillage is done in the optimum water range for workability and trafficability, the machinery used have low weight and low tyre pressure inflation and if is used in combination with deep rooting system crops/legumes in crop rotation, the mouldboard ploughing has positive effects on infiltration rate, aggregate stability, increasing crop yields and profitability.

Subsoiling SICS: stakeholders observed that by applying it every year, it is time and energy consuming leading to an increase of workload, and the financial benefits for farmers are not significant. Also, by using high levels of chemical inputs there may increase the health risk due to nutrients leaching and infiltration in groundwater table. In dry years, there is a potential risk of crop failure because of the water stress for crops during the growing season. On the other hand, subsoiling improved the soil indicators such as infiltration rate and bulk density which resulted in an increase of crop yields leading to improving the farmer reputation.

Chiselling SICS: it was found by the stakeholders that by using high levels of chemical inputs there may increase the health risk due to nutrients leaching and infiltration in groundwater table. On such heavy textured soil, there is a potential risk of crop failure because the weed control cannot be realized in a proper manner and the use of deep rooting system plants in combination with chisel tillage does not result in high crop yields. On the other hand, it has positive effects on aggregate stability because the soil disturbance by tillage implements is kept at lower level.

Main important findings

Soil improving cropping systems can have positive effects on soil quality by protecting the soil from different threats. In our case study the main soil threat found was natural subsoil compaction. This was mainly caused by heavy soil texture within the whole soil profile, but also can be due to soil tillage done in un-proper moisture conditions, un-controlled traffic at the soil surface, use of high axle load equipment and high tyre pressure.
The mouldboard ploughing SICS may be a solution for compaction alleviating, recommended by the stakeholders, if is done in optimum water range for workability and trafficability, low weight machinery are used and low tyre pressure, controlled traffic, use of deep rooting system crops/legumes in crop rotation.

Another solution for mitigation of the natural subsoil compaction on clayey soils may be the application of subsoiling as a measure used in practice by farmers. Based on the above-mentioned drawbacks and benefits of the subsoiling SICS, it was recommended by the stakeholders that this tillage type should be done periodically at 3-4 years.
Another measure for soil quality conservation and compaction mitigation recommended by the stakeholders was the use of leguminous crops/deep rooting system crops in crop rotation. This can be an appropriate measure for nitrogen fixing in soil, which results in decreasing the chemical fertilizers doses for the next cultivated crop in rotation. The leguminous crops also improve soil quality by increasing the structural aggregate stability leading to a good soil aeration status and water regime.

Stakeholder analysis conclusions

Based on the stakeholders analysis of the tested SICS in our study site area, in order to mitigate the natural subsoil compaction the best SICS to be implemented by farmers in practice is to use a combination of the two out of three SICS treatments which were tested, namely the application of the mouldboard ploughing annually and of the subsoiling periodically at 3-4 years. In this way is prevented the formation of the hard pan layer at the base of tillage depth. In addition, on such clayey soil, it can be used in crop rotation the deep rooting system crops / legumes. Such crop types improve the soil quality by increasing the structural aggregation which can have positive influences on soil aeration status and water regime.

One of the requirements of quality management of soils in general, and of arable soils in particular, is knowledge of the dynamics of physical and chemical characteristics especially of those which are the most sensitive under human activities. The impact of application of the selected SICS on the soil indicators showed that the most sensitive properties to the tested cropping systems were the physical ones.

Discussions around Impacts and Future Impacts from the SoilCare project

The main aim of the Final Stakeholder Workshop (which was held on 20th of April 2021) was to present the results of the 3 tested SICS for mitigation of soil compaction within our Study Site together with their drawbacks and benefits. This was done for the stakeholders in order to determine which one is the most suitable to mitigate the soil threat in the area and, at the same time, to have financial benefits for farmers without further degradation of soil quality. The experiment conducted in our Study Site evaluated the effect of 4 different tillage practices (3 SICS variants and 1 control variant) in order to mitigate soil compaction under three different crop rotation schemes which included legumes and cereals. The 3 tested SICS were as follows: mouldboard ploughing with furrow inversion at 25 cm depth, subsoiling at 60 cm, and chiselling at 25 cm depth without furrow inversion, while the control variant was: 2 times disking at 12 cm depth.

The stakeholders were very interested in the results obtained for the 3 tested SICS within our study site area, but also they received much information about soil characteristics from the Study Site area, mainly information on soil physical and chemical properties.
Based on the stakeholders analysis of the tested SICS in our study site area during the Final Stakeholder Workshop, in order to mitigate the natural subsoil compaction the best SICS to be implemented by farmers in practice is to use a combination of the two out of three SICS treatments which were tested, namely the application of the mouldboard ploughing annually and of the subsoiling periodically at 3-4 years. In this way is prevented the formation of the hard pan layer at the base of tillage depth. In addition, on such clayey soil, it can be used in crop rotation the deep rooting system crops/legumes. Such crop types improve the soil quality by increasing the structural aggregation which can have positive influences on soil aeration status and water regime.

The main impact from the obtained results presented at the Final Stakeholder Workshop is that the farmers are willing to implement in practice the recommended SICS for mitigating the soil threat in the study area. Moreover, some of the farmers from the study area said that they already implemented in practice one of the tested SICS, namely they used subsoiling tillage in their farm plots.

Based on the analysis, discussions and feedback collected from stakeholder during the Final Stakeholder Workshop, the younger farmers seemed to be more willing to take up and implement new soil improving cropping systems.

Another impact of the SoilCare project, it could be considered that whether older generations of farmers can also be targeted to adopt new SICS faster. From this point of view, it could be an opportunity for older generations of farmers to make a step backward and pass the farms

to the younger generation. Some of the soil improving practices will require farmers to learn about these techniques, their application to different soil conditions as well as their benefits in order to change their mentalities about these practices.

As a future impact, the stakeholders from the Final Stakeholder Workshop expressed their opinion that SoilCare project research findings should be made accessible and widely disseminated among the farmers and educational activities should be encouraged. For example, the SoilCare project results should be disseminated on the ICPA institute's website or via multiple social media channels, or through elaboration of some factsheets which present the soil threat (compaction in our case study) and solutions to prevent and remediate this threat.

These factsheets can be distributed directly to farmers by face-to-face meetings or at agricultural fairs organized for farmers on different occasions. In addition, these factsheets can be spread among students from agronomy universities and high schools, because they can be good educational materials for study of the soil threats.

Also farms visits and demonstration days may be organised in farms where soil improving cropping systems are already implemented in order to encourage other neighbouring farmers to effective adopt such soil conservation practices.

SPAIN

SoilCare
SOILCARE FOR PROFITABLE AND SUSTAINABLE CROP PRODUCTION IN EUROPE

Final Stakeholder Workshop Report

Almeria, Spain

Authors

Emilio Galdeano-Gómez, José A. Aznar-Sánchez, University of Almeria (Spain)

February 2021

Contents

Introduction

The main objective of the SoilCare project is to contribute to the conservation and improvement of the soil quality of the farming ecosystems in Europe. With this aim, different agricultural methods (SICS) were evaluated at various study sites throughout the continent. Once the results obtained at the various experimental farms where the different methods are used have been assessed, the goal is to promote the widespread adoption of those practices that have proved most successful. However, such an implementation process is not possible without the support of all stakeholders involved. For this reason, from the outset of this initiative, the project has made every effort to involve as many stakeholders as possible.

We have currently reached the presentation phase of the results obtained. In line with standard project protocol, we propose a forum of discussion and dissemination of said results with a vast group of stakeholders. This document presents the conclusions obtained from the synthesis of the research results on the adoption of SICS in Almeria, Spain. For this purpose, a workshop was held with representatives from different groups of stakeholders involved in the implementation of SICS in said area. Table 1 contains the names of those who participated in the workshop, displaying their corresponding institutions and stakeholder groups.
Due to the current situation caused by the COVID-19 pandemic in Almeria, it was decided that the workshop would be held online. Participants were called to attend a video conference using Google Meet on 19th February 2021. Thus, all parts of the session were adapted to the video conference format. The meeting included the presentation of the project results, a discussion period to address the various points on the agenda, and a final round of comments for each of the participants to share their key conclusions. The workshop lasted from 5 p.m. to 8 p.m.

The workshop had several objectives:

- Present and discuss the main results obtained following experimentation with the various SICS with the stakeholders involved.
- Identify the possible benefits that the experience of participating in the project has for the participants.
- Identify and propose different options for the dissemination of the project results that could contribute to increasing the adoption of SICS.

Table 1. Workshop participants

Institution	Stakeholder group			
	Technician	Farmer	Policymaker	Researcher
University of Almeria				X
University of Almeria				X
Finca el Molino Machero (almond)		X		
Producer of vegetables		X		
Cortijo La Vieja (olive oil)		X		
Alvelal	X			
Mañán	X			
Cajamar	X			
Local Action Group of Filabres-Alhamilla			X	
Council of Agriculture - Junta de Andalucía			X	
Local Action Group of Levante			X	
University of Almeria				X
University of Almeria				X
University of Almeria				X

In order to achieve the proposed objectives, the workshop followed a specific agenda. First, the project results were presented, comparing them to the results that had been estimated. Second, the results obtained were discussed. This discussion summarized key points and identified impacts and benefits that either had taken place or could in the future. Finally, workshop participants were asked if they had observed any differences related to age, group or gender during the experiment process.

Research findings

We begin with a brief description of the study sites, the methods implemented at each of them

and the results forecasted.

José Ángel Aznar and Emilio Galdeano were in charge of presenting the project, highlighting its objectives and moderating the session. Fernando del Moral and Yolanda Cantón were responsible for describing the study sites, the methods being tested at each of them and the results obtained.

1. Tabernas: the methods at this site include:

    1.A. Use of controlled deficient irrigation and covering with plant trimmings.

    1.B. Use of controlled deficient irrigation and planted cover crops.

2. Agua Amarga: the methods at this site include:

    2.A. Use of controlled deficient irrigation and adventitious root grass cover.

    2.B. Use of controlled deficient irrigation and planted cover crops.

Table 2 displays the different results initially expected with the application of the SICS at the study sites.

Table 2. Key impacts of adopting SICS at the study sites.

Component	Positive impact				Negative impact			
	1A	1B	2A	2B	1A	1B	2A	2B
COST								
Pruning								
Harvest	+							
Transport	++							
Processing					-	-	-	-
Compost Production		+			-			
Application to crop								
Fertilization	+				-	-	-	-
Seeds						-		
Manual labor						-		
Water	+	+	+	+				
YIELD								
Amount	+	+				-		
Quality			+	+				
INCOME			+	+				
ENVIRONMENTAL BENEFIT								
Organic soil material	+	+	+	+				
Soil erosion	+	+	+	+				
Soil compaction	+	+	+	+				
Soil crusting	+	+	+	+				
Appearance of pests	+	+	+	+				

Biological pest control	+	++	+	+				
Desertification	+	+	+	+				
Contamination (water/soil)	+	+	+	+				
Soil salinization	+	+	+	+				
Biodiversity	+	+	++	++				
Nutrient imbalance	+	+	+	+				

Agua Amarga Study Site

This property is located in the Natural Park of Cabo de Gata-Nijar. There are no restrictions in this area regarding water use, which, in our view, allows for excessive consumption. Such excess is starkly inconsistent with the semiarid landscape where it is located, especially when this consumption can have undesirable impacts, such as leachings high in fertilizers, while also lowering water use efficiency and, thus, overall economic performance. By using controlled deficient irrigation, the goal is to substantially decrease water consumption (and related fertilizers) while maintaining current production. In this case, the benefit will come in the form of lower crop costs and it will have positive economic and environmental impacts.

The experiment began in 2018 and data have been collected for the years 2019 and 2020. Due to the time limitations of the experiment, the results obtained are relatively scarce. The installation of adventitious root grass and cover crops was quite low during the first year, which is why no significant differences were found in any of the treatments with regard to control of water and fertilizers. As for water management, during the first year an 8% reduction of total volume of irrigation water was applied in the postharvest period, while a 15% reduction was applied in the second year. The decision was made to conduct these reductions during the postharvest period as it is when trees require the least amount of water.

In relation to soil quality, the values measured were the soil moisture characteristic curve, hydraulic conductivity, terrain roughness, apparent density and soil porosity and risk of compaction and erosion. As for the chemical properties of the soils, measurements were taken to determine the content of potassium, magnesium, calcium, sodium, electrical conductivity, pH of water and potassium chloride. Finally, assessments were conducted to analyze crop diseases and, when they were not part of treatment, adventitious root grass pressure and crop rooting capacity. The statistical results were not significant for any of the measured values. Nevertheless, certain positive trends were observed in certain key parameters, such as the increase in hydraulic conductivity of saturation and a slight decrease in apparent density.

Therefore, positive results have been obtained with regard to cost savings, primarily due to the reductions in water consumption. As for the rest of the items that imply a cost, the resulting trade-off meant no significant impacts could be observed. In relation to crop yield and quality, there was a positive impact. There is no data on the economic benefit. With regard to the

environmental impact, no significant variation in the variables can be confirmed. However, a positive trend is observed that could be confirmed in future growing seasons.

Tabernas Study Site

This farming estate customarily uses shredded plant trimmings mixed with soil at the surface level. However, the soil still features a weak structure in addition to a rough texture, favoring surface crusting. Crop cover, whether adventitious root grass or planted crops, can help to stabilize this structure, making it more resistant to crusting and improving capacity for the infiltration of water from the few precipitations in the area, which would ultimately improve the hydric balance. It is crucial to carefully choose when to carry out cutting so these gained advantages do not become problems due to competition for water. As an added value, cover crops can help to stimulate biological processes within the soil, improving the assimilation of nutrients scarcely available in the soil and generating new habits for entomofauna.

Regarding the results, significant differences can be observed in certain variables. For example, the data on labile soil organic carbon improve substantially, above all with the use of cover crops. It must be considered that establishing cover crops is highly dependent on the presence of rainfall, meaning there is no specific period for their planting. A positive effect is observed for the appearance of magnesium, as well as a partial positive effect on the interchangeable potassium contents in the soil. However, nitrogen levels fluctuate, obtaining significant results in the second season but failing to do so in the first. As for other features, an increase in total electrical conductivity was detected in the continuous deficient irrigation. This aspect must be controlled considering the soil salinity in the area can cause a host of problems. With regard to apparent density or infiltration, no noteworthy differences were found for any of the methods.

Although no water savings can be observed in this case, there was instead an improved distribution of water resources over the course of the year which allowed an increase in fruit quality. Once again, there was a trade-off between the increase and decrease of some costs which means no significant impacts can be observed. As in the first case, there are no data on economic benefits either. As for environmental impact, significant variation in the variables cannot be confirmed, yet a positive trend was again observed that could be confirmed in future seasons.

Discussion of project findings

The participants expressed interest in knowing the impacts the methods had on production yield and quality. In this regard, in the case of the study conducted on fruit trees, a certain positive impact was achieved in both quality and yield. However, such improvements in quality and yield are not common when applying deficient irrigation, which is why this particular aspect was analyzed. It was concluded that, prior to the experiment, an excessively high amount of water was being supplied, which meant there was a very wide margin for improvement.

In the case of olive trees, no increases in production were obtained, mainly because they had previously received a much lower and restricted water supply. In fact, in this case, the objective was not to reduce water consumption but rather to change its distribution over the course of the year to guarantee production. By receiving more water during blooming, it is possible to ensure better fruit setting. In addition, by withholding part of the water applied during summer and instead supplying it at the beginning autumn during fruit enlargement, it is possible to gain a substantial percentage of olive via slightly better fat content, equating to higher quality oil. In this sense, the results appear to indicate that improvements have been made in oil quality.

The conference participants discussed the benefits of planting adventitious root grass or cover crops, especially in the case of olive, which features very scarce water supplies and very low rainfall. This particular farm has rather serious problems with crusting, which makes tilling necessary, although intervention is minimal. In this regard, planting cover crops could reduce, even if slightly, problems with crusting. Ideally, cover crops would be planted when rains are expected, but the problem in this area is that rainfall is highly variable and scarce. Thus, it is necessary to pay close attention to when precipitations are forecast in order to carry out the planting of cover crops, so the latter have sufficient water to settle and grow. In the case of stone fruit, this is not a problem as there is a greater water supply for crops meaning, at least along tree rows, there is enough moisture to favor the emergence of adventitious plants and cover crops.

One point addressed was the possible reduction of fertilizer use as a result of applying these methods. In the case of the olive crop, as it is organic, the use of fertilizers is absolutely limited. In this regard, the use of cover crops can favor the appearance of nutrients that are not typically available in the soil. Therefore, despite the difficulty of establishing cover crops in the area, the latter could have various positive effects on the soil and, consequently, on the crop itself. In the case of fruit trees, although fertilizers can be utilized, the use of cover crops and the planting of adventitious root grass could imply a savings in this regard. Nonetheless, not enough time has transpired to observe the positive effect that the adventitious plants and the cover crops could have because, besides obtaining relatively low cover in the first year, the conditions in this area make the presence of these plants temporary and quite short.

Overall, the experiment obtained statistically non-significant results. The participants remarked that data collection over the course of only two years limits the chances of obtaining more robust results. The general opinion is that the effects of these practices are only observable in the long term. In any case, the participants believe, despite not being significant, the results reveal certain positive trends that could increase in the years to come.

Impacts that have happened

In the case of stone fruit, those managing the estate decided to establish a continuous deficient irrigation system, reducing total water consumption by 25% over the course of the year. Although the results obtained in the study conducted using controlled irrigation proved satisfactory, the estate managers finally opted for continuous deficient irrigation due to issues of technical and economic viability. During the experiment, the deficient irrigation was applied by means of manual water cuts to specific crop rows. Nevertheless, this is not viable over the entire estate due to its vast expanse and the cost of manual labor derived from such a practice. Consequently, the managers plan to apply the continuous deficient irrigation by limiting the water pressure to the drippers, thereby reducing the total emission flow by 25%. The fact that the estate managers chose a considerably larger water reduction than the amounts applied in the tests demonstrates that the results obtained were very positive, and it is also a testament to their satisfaction. In the case of olive, the owner has chosen to plant a cereal cover crop on the entire estate every year and will implement the controlled deficient irrigation proposed by the researchers on the land as well in the future.

The main impact achieved is that the managers of the estates where the experiments were conducted have opted to incorporate the methods evaluated in the project or at least an adaptation of them.

- "As far as I'm concerned, something rather remarkable has been achieved and it's been a great help to growers in both cases and it's made them change their minds".
- "I think an overall benefit is having been able to implement several techniques that were considered to be quite useful. It was possible to implement them on land with special characteristics, and they've shown to achieve results and that they're quite reliable".
- "Specifically, one of the growers on the estate was much more traditional and was more difficult to convince when the time came to incorporate the methods, but, in the end, after seeing the results, he opted to implement the proposed methods".

Evidently, the incorporation of these practices brings a wealth of positive impacts, not only on the crop but also on the resources utilized and the surrounding area where the estates are located.

- "What has surprised me in particular is the decision of the company to reduce by a quarter the total water supply. This is a drastic impact that needs to be watched over time to verify if there is a drop in yield. Nevertheless, from my point of view, this could bring about an improvement in the quality of the fruit in terms of sugar content. There could even be a certain benefit in terms of the impact of specific pests when the plant is stronger or more resistant, without entering a state of stress."
- "It's great that the owner of the olive grove decided to incorporate both experimental methods as it might encourage other growers to do the same".
- "Planting adventitious plants and cover crops helps to increase biodiversity. Furthermore, bearing in mind that by planting them you are helping the trophic chain

in the area, the effect can be even greater."

- "There is an important benefit from the environmental point of view, not only for the immediate area around the estate but also downstream, eventually reaching the sea".

In economic terms, there are also positive impacts derived from water savings.

- "I think it's incredible that this experience has made it possible for the grower to reduce total water supply by 25%. This is a huge step as it will greatly reduce water costs. Moreover, you can also lower the cost of phytosanitary products because there will most likely be fewer pests and diseases".
- "In economic terms, there would be a decrease in costs as a result of the amount of water needed. What's more, the managers of the estate observed no increase in the amount of manual labor as a result of the implementation of these methods, nor an increase in costs due to planting or letting adventitious plants grow. In fact, leaving adventitious plants implies a savings in herbicides that will no longer be needed.
- "An additional reduction in costs could be derived from reduced soil compaction, given that the trend we've seen is that there's a decrease in the apparent density. Furthermore, it's been observed that in the area where most of the adventitious plants are grown there is less crusting, so there's an improved infiltration capacity for the scarce precipitations in both study areas".

Future impacts

There were positive impacts on different aspects on the estate itself and on the environment, such as the reduction of possible pests thanks to the use of adventitious plants or cover crops, a decrease in the carbon footprint, as well as an increase in soil biodiversity.

- "A reduction in pests as a result of using cover plants is possible as long as the crop is not stressed by an extraordinarily drastic reduction in water".
- "In terms of carbon footprint, currently, I'm not sure if it would have a quantifiable direct impact because we haven't seen a clear trend in the results. However, a reduction in the soil respiration rate necessarily implies the storing of carbon".
- "No measurements were taken as far as soil diversity is concerned because it is so complex to do so. However, if it had been quantified, it would have probably been one of the variables that supplied a faster answer and it would continue to rise in the years to come."

Regarding how to disseminate the findings to a larger group of people so they may benefit from them and how to support growers so they will apply the methods, the participants agreed on the need to accompany growers during the implementation process. Thus, the grower would always be in contact with a person who could indicate how to correctly carry out the process and how to face possible problems that may arise. In addition, in relation to the disclosure of results, it could be quite useful to contact the representatives of grower associations.

- "The people who need to be convinced are those who work directly with growers, for example, irrigation association technicians. These are people who work with a huge number of hectares and can quickly see the benefit of decreasing water supply by, for example, 8%".
- "Technicians are the ones who also must know the data so they may transfer it to other technicians, to cooperatives and to growers. But, if growers don't have any guidance to implement a given practice on their land, it is far more difficult, even if the knowledge is transferred. What could be proposed is that, rather than implementing the method on the entire farm, which they might be hesitant to do, they could try on a small portion of their land and verify for themselves that the olive trees won't die, they won't dry out, and that way they'll start to test it out".
-
- "For me, the key point is that the individual who should transfer the technique to the grower is their regular technician, who they know will guide them throughout the entire set-up and application of the technique and this person will somehow adjust said technique to their specific conditions. In my opinion, it would be an absolute error if growers attempted to implement this technique without adequate technical support".

Other important aspects include the market itself and consumer behavior, and economic incentives must also be taken into consideration.

- "I truly believe that the future of the use of this type of practice depends on whether the commercialization of production is economically profitable under these specific conditions. As long as this is not the case, and it is simply superficial aid or greening payment, it won't go anywhere."
- "There's a lot of aid out there. For example, subsidies have been given out for years for planting cover crops. However, it doesn't may sense for them to just arrive and say 'if you do this, I'll give you X amount per hectare' because that solves nothing. That's why there must be guidance provided so growers do it correctly and gain an added value for their production".
- "I think we'll have a strong possibility to grow in this sense if the European green pact and the farm to table strategy get serious, that is, when there is a required reduction in the use of phytosanitary products, fertilizers and so on and when the trend towards organic agriculture is truly dominant. Right now, those growers who stay a step ahead, like those we've conducted the trials with, will have a business advantage".

Furthermore, there is a strong emphasis on the need to conduct this type of project over a longer period of time.

- "All these projects are necessary because there is an enormous need for training and guidance in farming. The small drawback that I observe in all these projects is how short they are in time. There are loads of trials, but they're limited in time and, in the end, none of the projects is long term. For example, perhaps this project should be conducted for several years more; now it's ending and maybe another similar line of research will arise in the near future".

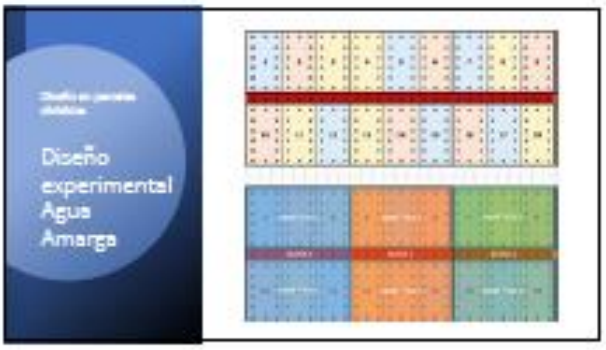
The participants were asked if they had observed differences in relation to gender or age when implementing the practices with growers, and the general response was that they had not perceived any differences either while conducting the project or during their career.

- "I haven't seen any big differences in terms of gender. I've seen men who were extremely reticent and others that were very forward-thinking, just like among women".
- "Although it's true that there are usually more men than women in agriculture, I haven't found any differences between the actions of one or another. I know women that have supported certain changes in crops, but I know men as well. As far as age, I've met young growers who have no interest in these methods and others that do, and the same is true among older generations".

However, during the workshop the female participants provided various comments related to sociocultural aspects and biodiversity which the males had not noticed.

Appendix

A. Presentations of results

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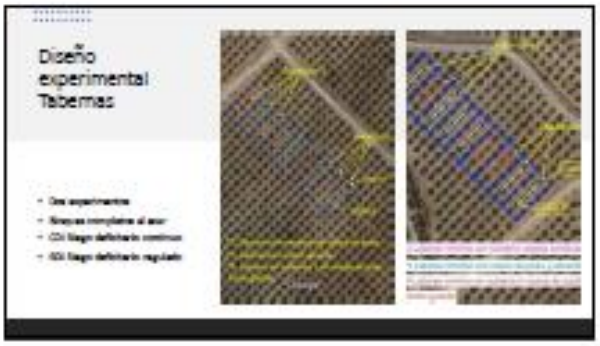
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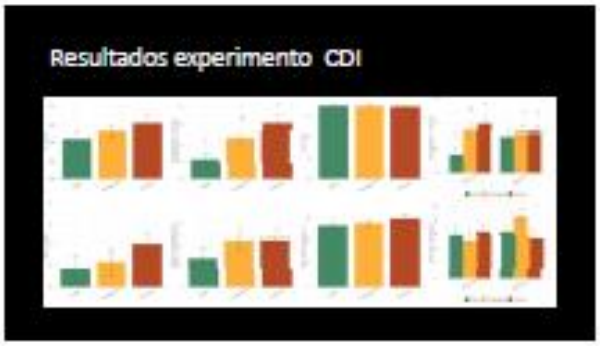
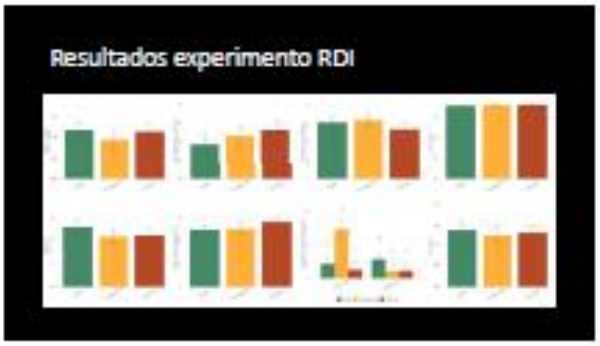

Resultados experimento CDI


Resultados experimento RDI

Validation

Are project results plausible and/or in line with your understanding?

Validación

¿Los resultados del proyecto son viables y/o están en consonancia con sus conocimientos?

1

Usefulness

How could you use results of this project in your work? Please, specify which results can be used in which ways.

Utilidad

¿Cómo podría emplear los resultados de este proyecto en su trabajo? Por favor, especifique qué resultados pueden utilizarse de qué manera.

2

Results transfer

How could we get our findings to more people who can benefit from them (and how you could help)?

Transferencia de resultados

¿Cómo podríamos hacer llegar nuestros hallazgos a un mayor número de personas para que puedan beneficiarse de ellos (y cómo podría usted ayudar)?

3

Benefits

What benefits have you gained from SOILCARE already?

Beneficios

¿Qué beneficios ha obtenido hasta ahora del programa SOILCARE?

4

Support

How would you like to be supported in using or implementing project/research findings?

Soporte

¿Cómo le gustaría que le apoyaran en la utilización o aplicación de los resultados del proyecto/investigación?

5

Future impact

Tell us one thing you want to remember or one thing you would like to do with what you have learned today.

Impacto futuro

Indíquenos algo que quiera recordar o algo que le gustaría hacer con lo que ha aprendido hoy.

6

SWEDEN

SoilCare
SOILCARE FOR PROFITABLE AND SUSTAINABLE CROP PRODUCTION IN EUROPE

Sweden SoilCare study site experiment:
Incorporation of straw into the upper subsoil

Gunnar Börjesson, Martin A. Bolinder, Thomas Kätterer and Holger Kirchmann

Report from the Multi-Stakeholder Advisory Panel (MSAP) And other local and national stakeholders workshops

March 2021

Introduction

This report contains the findings for feedback from a workshop with local and national stakeholders as well as from a workshop with the Multi-Stakeholder Panel (MSAP). The purposes of the workshops were to present the results from our research, and to discuss with stakeholders in order to obtain a feedback on those results. Furthermore, we were gathering comments and opinions concerning validation and usefulness, future impacts and aspects regarding the need for more research.

Workshop with local and national stakeholders

The workshop with the local and national stakeholders took place on March 8, and the duration was around two hours. This workshop was aiming at broadening our audience who could be interested in the project's results. For this purpose, we were giving an invited presentation within the regular series of seminars of The Rural Economy and Agricultural Societies (HIR). HIR is a national body consisting of independent units in seventeen different Swedish Counties. It is providing advice and knowledge transfer to rural businesses involving mainly farmers. The staff is also conducting field trials, research and development. HIR is a bridge between research and development and rural enterprises, with clients ranging from family farms, agricultural colleges and universities to public services. Education through seminars and courses is an important vocation of HIR. In addition to our presentation, this meeting was addressing other issues relating to improved management, also relating to soil improving cropping systems (SICS) such as liming and drainage. Participants were asking questions both during and after each of the presentations. At the end of our presentation, we were also announcing our second workshop with the MSAP, inviting stakeholders to contact us for participating in the latter. This group of stakeholders is quite a heterogeneous mixture of farmers and/or extension scientist acting in the "Östergötland" County, located in south-eastern Sweden. There was forty persons in total attending this Microsoft Teams-meeting. The participation was slightly in favour of the masculine gender, with a little less than ten women.

Workshop with the Multi-Stakeholder Panel

The workshop with the MSAP took place on March 18, and the duration was around two hours. These stakeholders have been involved more or less since the beginning of the SoilCare project and we were inviting all of them to a Microsoft Teams-meeting. When sending out the invitation, we were distributing our fact sheet, as well as a document with questions and those who were unable attending the workshop was returning their answers. This group of stakeholders consists of experienced extension scientists working for the Swedish Board of Agriculture (www.jordbruksverket.se), and The Rural Economy and Agricultural Societies (www.hushallningssallskapet.se) as well as senior consultants in the agri-business sector, and a farmer and consultant. Including Gunnar Börjesson and Martin A. Bolinder representing the

Swedish study site, we were ten participants in total for this exercise. The distribution of men versus women were uniform, with five persons from each gender.

Discussion of project findings

Research findings

Brief background

The study site is located on a farm at Orup in the southern-most county (Skåne) of Sweden. This area is containing deposits of ice movement from northeast to the central part of Skåne. The site has been under cultivation for at least a century and is tile-drained. The soil has a sandy loam texture throughout the profile, and the climate is cold temperate and humid. The subsoil is naturally compacted since its formation under land ice, and root growth of crops are restricted to the topsoil with hardly any roots below 30 cm. A pilot study was starting in September 2018 using an adapted HE-VA sub tiller equipment, aiming at improving soil structure through the supply of undecomposed organic material in combination with a mechanical subsoil loosening. Our hypothesis was that loosening and incorporation of fresh organic matter into subsoil would stimulate biological activity and lead to stabilization of soil structure at a lower density enabling roots to grow deeper. Consequently, we were expecting higher yield through a better water and nutrient uptake by roots exploring a greater volume of soil. For that purpose, we established three treatments in a randomized block trial with four replicates: (a) loosening of subsoil (to a depth of about 35 cm) without incorporation of organic material, (b) loosening of subsoil and incorporation of straw pellets at amounts of about 25 Mg ha^{-1}, and (c) a control treatment. We were injecting straw pellets under pressure into the upper subsoil, through oval openings in metal pipes welded behind each vertical tine, by pumping it from a tank mounted on the front of the tractor. Loosening of subsoil were applied once (i.e., 2018), thereafter normal tillage practices including mouldboard ploughing to a depth of about 25 cm were done as usual in all plots. The crops grown were winter wheat in 2019 followed by sugar beets in 2020, and fertilized according to local recommendations.

In the year with winter wheat, we were using one plot per treatment for making soil profile descriptions. Where we evaluated the portions of subsoil (24-35 cm) volume affected by subsoiling, and visually assessing the presence of roots by counting the number of roots along a 10-cm line at various depths (10, 20 and 30 cm). A more detailed soil sampling was made in 2020 about 6-weeks before harvest, within a small area in the middle of each plot that were kept free from sugar beets plants since around mid-summer. In this area, a soil pit 65-75 cm long and 25 cm wide was dug, where six undisturbed soil cylinders (7.2-cm diameter, 5-cm height) were taken in the 10-15 cm depth and six in the 28-33 cm depth, by placing the cylinders one after the other in a row at a distance of about 5 cm between each. A sampling scheme allowing us to ensure that we covered a representative area subject to subsoil loosening. Before

removing the cylinders from the 28-33 cm depth, we also made six measurements with a penetrometer along the row with cylinders. For winter wheat, dry grain yield (15% water content) and gluten content were determined, while we were evaluating clean tuber yields (wet weight) and sugar content for sugar beets.

Summary of main research findings

- Distinct stripes in the subsoil but not the whole upper subsoil layer was affected
- Volume percentage of the subsoil affected through loosening and straw incorporation varied between 38 to 45%
- Surprisingly, straw was not mixing with subsoil in rows but located at the bottom of subsoil rows together with topsoil, and subsoil moved into topsoil irregularly
- Rooting characteristics were improved by subsoiling
- More roots were present in the subsoiling treatments
- Almost no roots were present in the subsoil for the control treatment
- Maximum penetration into the subsoil (>24 cm) was about 4 cm in the control and 11 cm in the subsoiling treatments
- Maximum rooting depth was about 27 cm in the control, 30 cm in subsoiling alone and 35 cm for the subsoiling + straw treatment
- The impact of subsoiling on yields of cereals and sugar beets was not significant
- Subsoiling does not affect the whole hectare but only a portion of the area (distinct subsoil stripes) and differs in this sense from other SICS affecting the whole area
- Scaling yield results against the volume percentage of subsoil influenced by subsoiling (using yield of the control as a baseline) increases the effect of subsoiling on relative yields
- Such recalculations (scaling) for winter wheat indicated a relative yield for subsoiling between 107 to 108%, and between 104 to 105% for the subsoiling + straw treatment.

<u>Discussion of research findings</u>

Workshop with local and national stakeholders

The issues addressed in this workshop included not only the presentation of results from our Swedish SoilCare study site. The other presentations during this workshop was covering several management practices. Notably, we were also presenting results with respect to optimal levels of pH and phosphorus assessed in long-term field experiments, one consultant was presenting results from drainage research experiments, and another person from HIR was presenting his personal experiences with drainage on a farm. Consequently, the discussion following all

presentations was also representing views relating to soil improving cropping systems in general (**note:** this consideration also applies to the sections impacts that have happened & future impact from this workshop). We are summarizing the key discussion points following immediately after the presentations below:

- The participants found that our SoilCare project on subsoiling and incorporation of straw into the upper subsoil was interesting and wanted to know more
- There was a discussion concerning the applicability of our SICS in other regions in Sweden. Notably, whether similar studies are also being conducted in other countries with similar soil and climatic conditions, the UK was raised as an example
- The participants generally found that our results were plausible and in line with their understanding. For example the improved root growth and rooting depth we were observing at our study site
- There was a discussion about the fact that we were not observing any significantly higher yields during our experiment. Participants seemed to be recognizing that this type of SICS may eventually take several years before the beneficial effects shows up, and in this regard some participants were mentioning earlier and similar experiments conducted at the Swedish University of Agricultural Sciences (SLU)
- There was a discussion about liming, in particular structural liming and whether we had considering doing this in the upper subsoil. This issue was raised since structural liming is also partly related to solving soil compaction problems by creating a better soil structure, especially when this lime is incorporated into the soil
- There was a discussion about the economics relating to liming, and a new practice were mentioned where lime is mixed with liquid manures (there were various opinions whether this could be considered as some kind of maintenance liming)
- The discussions regarding drainage was mostly relating to the economic aspects. However, participants were also discussing issues relating to the loss of nitrogen and phosphorus to surface- and ground-waters. Participants were also raising the fact that drainage has also a beneficial effect concerning compaction by preventing field traffic to occur during too wet soil conditions.

Workshop with the Multi-Stakeholder Panel

Most of these stakeholders have been involved more or less since the beginning of the SoilCare project, and others have a long experience in the agronomic sector. Consequently, they found the findings were generally in line with their understanding, and plausible. Other key discussion points were including:

- Most of these stakeholders were highlighting the fact that in their work, they are observing soil compaction quite often in the area

- In that regard, the problems they are encountering in relation to soil compaction is poor water infiltration (drainage problems), and farmers' sometimes have to delay seeding in the spring. There are also problems with rooting depth of the crops and weed infestation, and all these aspects is leading to poorer crop growth and yields. The soil is more difficult to work with the machinery, which is also leading to higher fuel consumption. Furthermore, the heavier machinery used today is a concern among many farmers' in the area. In extreme cases, farmers' have even stopped growing some crops (e.g., sugar beets) on certain particularly problematic soil types
- These stakeholders were also raising the fact that we were not observing any differences in crop yields during our experiment as a major concern. There was a discussion that the soil at this particular site is among the most difficult soil types in the area, so that it was maybe not so surprising we did not observe yield increases
- In that regard, this group of participants were also mentioning the earlier types of similar experiments conducted at SLU (at other locations), where it was sometimes possible to observe positive effects on yields even several years after the experiments had stopped. Thereby, the necessity of having longer-term experiments was considered important
- Followed a discussion on long-term (i.e., starting in the 1960s) experiments in general, where a concern regarding the fact that some of them are becoming less representative of contemporary agronomic practices and crop types, and thereby sometimes having less representative yields. Although some modifications are continuously made (e.g., such as liming to adjust soil pH), this remain a problem common for all types of long-term experiments throughout the world. It is not always easy resolving these problems because of varying objectives (e.g., short-term variety trials versus examining long term management effects such as those of fertilization regimes or crop residue removal treatments, the latter can be more stable through time and it is always possible making relative comparisons)
- There was a discussion concerning the fact that some of the subsoil was mixing with the topsoil in this experiment, and that farmers are particularly interested in increasing the soil organic matter content in the arable layer. Thereby, from this aspect, the SICS we were testing in our experiment may raise concerns among farmers
- However, we were explaining that the equipment used in this particular experiment had been adapted (i.e., using much wider tines) mainly for injecting a large amount of organic material into the subsoil, and for doing that, it was necessary to run the equipment twice in each of the experimental plots, and at a very low speed of the tractor
- Normally, when this type of standard equipment (i.e., tines not so wide) is used in the farmers' fields and with normal speed of the tractor, then only the subsoil is affected and there is almost no mixing of sub- and topsoil, and there is almost no or a very small disturbance in the topsoil. Farmers' in the region well perceive the use of this equipment.

Impacts that have happened

Workshop with local and national stakeholders

Since the local and national stakeholders were not familiar, neither with our specific SoilCare study site experiment or the SoilCare project in general (as opposed to those in the workshop with the MSAP), it was not realistic to expect that these stakeholders would already have gained any explicit benefits from SoilCare. However, subsoil loosening, and in combination with addition of organic materials was very positively received by the participants as a potential solution for subsoil compaction. On the other hand, our results with respect to optimal levels of pH and phosphorus assessed in long-term field experiments are already influencing the agri-business sector. Indeed, these findings are under consideration for eventually changing current recommendations. Regarding the presentations on drainage, a general outcome of the discussions was that this is economically feasible and beneficial. Not only increasing yields are financially supporting this, there are also several other indirect benefits, whereof one consultant were summarizing some of them during the workshop presentation such as earlier seeding and harvest, less problems with weeds.

Workshop with the Multi-Stakeholder Panel

Since these stakeholders are much more familiar with the experiment through our earlier stakeholder workshops, and their participation in a field day, we were having more in-depth discussions. A large number of thoughts and specific suggestions came up concerning the lessons learned, including:

- The absence of short-term yield increases we were expecting, is for the moment, suggesting some possible difficulties in making this particular SICS feasible in practice at larger scales
- It appears also difficult, making at present, the injecting under pressure (i.e., blowing into the subsoil) large amounts of external (i.e., not directly available in the fields) organic materials economically viable, mainly relating to technical difficulties and machinery costs
- However, our SICS were having two components, mechanical subsoil loosening and the injection of organic materials in the subsoil
- The mechanical subsoil loosening component (using the equipment in its standard form) alone have already been proven useful when applied at larger scales (i.e., in farmers' fields). Notably, when applied once (sometimes twice) in 5 to 6 year rotations in relation with establishing winter oilseed or sugar beet crops. This is foremost improving water infiltration properties (particularly important in the spring promoting adequate crop establishment), reduces soil erosion, and are having positive effects on yields that are sustained during approximately two years

- The idea considering the injection of other organic materials than straw pellets used in this study was discussed, such as sewage sludge or other liquid mixtures, it remain however probably difficult since the organic matter content is too low (i.e., mostly water when materials are in liquid form)
- Another idea is making only a mechanical incorporation of organic materials already available in the farmers' fields, such as for example a cover- or catch-crop like clover. Oil radish were also mentioned but may not be as appropriate because of disease problems for the main crops
- An additional major idea is trying to make the effect of mechanical subsoil loosening more persistent in time, and without adding external organic materials. This could possibly be achieved by establishing a perennial crop such as clover, shortly following the mechanical subsoil loosening, eventually using an under seeded spring barley crop.

Future impacts

Workshop with local and national stakeholders

There was a consensus from this workshop regarding the fact that in order to get the findings from the Swedish SoilCare study to more people who can benefit from them, it is necessary to repeat the experiment at other sites. This is because there was a concern regarding the general applicability of this SICS. Especially, since the usefulness may vary across soil types and climatic conditions. Furthermore, stakeholders were identifying that the difficulties in obtaining adequate and continuous financing was the main barrier for implementing research projects, and for promoting new findings. A better financial support is definitely warranted, not only in regard to our SICS but also for the other types of innovative projects that were discussed at this workshop.

Workshop with the Multi-Stakeholder Panel

Stakeholders were recognizing that this was a short-term pilot study on a site with a naturally compacted subsoil. Although we were able showing that treatments are positively influencing root growth and rooting depths, since they were not significantly affecting crop yields in the short-term, there is a need for longer-time studies. Preferentially on other crop and soil type combinations, eventually using other sources of organic materials, and perhaps for examining the effects of repeated subsoil-loosening treatments through time. The financial considerations were part of the discussions in this workshop as well, and the fact that it is not easy obtaining support for future studies. In order to get our findings to more people who can benefit from them, stakeholders were making the following suggestion:

- Several of the stakeholders were very interested in distributing our fact sheet to their colleagues

- It was also emphasized the The Rural Economy and Agricultural Societies can indeed help in communicating results to their members and farmers', and we could write an article in their book on field trials or at their website (www.sverigeforsoken.se)
- At the farm or field scale, the Swedish extension service is using a tool named "Odlingsperspektivet" for introducing environmental and soil fertility issues to farmers (within the national advisory program Focus on Nutrients (www.greppa.nu)). It is calculating changes in soil carbon, by comparing new management techniques relative to a baseline scenario (https://adm.greppa.nu/radgivning/mullhalt-och-bordighet.html). Our results could eventually be useful for this tool
- One stakeholder was suggesting to write an article about our SoilCare experiment in one of the upcoming issues of Focus on Nutrients newsletters
- One stakeholder was highlighting the fact that marketing of research results are more important than you think, and was suggesting (for future projects) that we should be inviting media (local) filming field operations (i.e., establishment of treatments), and to write articles in journals typically read by farmers and extension scientists.

SWITZERLAND

SoilCare
SOILCARE FOR PROFITABLE AND SUSTAINABLE CROP PRODUCTION IN EUROPE

Final Stakeholder Workshop Final Report

June, 2021

UBERN

Caspar Thut
Alexandra Gavilano
Felicitas Bachmann
Abdallah Alaoui

1. Introduction

The final workshop of SoilCare project was organized through bilateral meeting with the stakeholders because of two mean reasons. The lockdown due to the Covid, and the two initiatives against the pesticides that take place in June 13, 2021 in Switzerland which made the situation tense and contact with stakeholders impossible.

First, we have sent a document with the description of the SoilCare and the SICS assessed. This document includes the questionnaire presented in the second section of this report. Second, for the participant who did not replied, we called them to check whether they have any problem of understanding or other. This process lasted from February 2021 to June 2021. In total, we consulted 42 individuals among which we got responses from 19 participants to the questions (scientist (4), students (5), politicians/Federal Office for Environment (2), private compagnies (1), farmers (6), and agricultural association (1).

To collect the feedback from the above participants on the results of SoilCare, we have sent to them: (i) the brochure elaborated for this purpose, (ii) the results established within D5.3, and
(iii) a questionnaire with the following questions:

- Have you participated in any of the previous SoilCare workshops?
- Are the results of the project plausible and / or are they in agreement with your understanding?
- How could you use the results of this project in your work (specify which results can be used and in what ways)?
- How can we disseminate the knowledge acquired through the SoilCare project so that it could benefit more people (how could you help)?
- What benefits have you gained from SoilCare?
- How would you like to be supported in the use or implementation of project/research results?
- Name one thing you wanted to remember or one thing you wanted to do with what you have learned from SoilCare.
- What are the barriers for implementation of the SICS?

Information on the SICS considered

SICS 1 – GREEN VERGES

Farm: Organic farm without livestock in Hagenwil b. Amriswil/TG, Eastern Switzerland, organic farmer and farm manager, 9ha + house 78.35ha + 4 km away 7ha + leased land 3.5ha. Total 18ha arable land with this technology from total 97.

Detection methods: Meadow strips as tramlines

Description: Organic farming generally has a positive influence on the vitality and biodiversity of the soil. Fields exploited according to its principles in Switzerland contain on average up to 50% more mycorrhizal fungi and earthworms and about 10 to 20% more microbial biomass than fields exploited in conventional agriculture (Honegger et al., 2014).

Field information

The farmer (HS) owns an organic farm of 27.7 ha without any cattle. He has converted to organic farming in 1993 and raises chickens and bees beside his cropping activity (winter wheat, grain maize, peas, millet, potatoes, green manure). His soil consists of loam, clayey loam and is weakly humified. His crop rotation is currently of seven years, including artificial meadow. In Switzerland, the organic producers must cultivate 20 % of the crop rotation area as an artificial meadow. Without livestock farming, artificial grassland makes little sense as a feeding area. He sows the artificial meadows directly into the wheat in April after harrowing. This usually succeeds very well. The soil is also green during the vegetation dormancy. The following advantages are to be expected: optimal erosion protection, higher productivity of the soil (humus build-up), less nutrient leaching, and protection of soil life.

Artificial meadow can also be used as a soil-improving cropping system in order to alleviate soil compaction in the form of so-called meadow strips (3 m wide). These meadow stripes can be used to drive heavy machines on without directly endangering the field. The combine harvester also travels along the artificial meadow strips and not over the entire field, which means that considerable pressure areas can be avoided. Each individual strip shifts every two years by 3 m, so that after 12 years the newly sown strip is on the same spot for the second time. Expected improvements are better water infiltration and storage, lower penetration resistance, higher aggregate stability and increase of biological activity:

HSK: Crops in between meadow

stripes. HSE: Meadow stripes.

Hypothesis

Better water storage
Higher penetration

resistance Higher stability

Water infiltration increased due to

roots Load bearing capacity of soil

Promotes the earthworm population (humus formers) – biological activity increase

Reduces stress on cultivated soil

SICS 2 – CULTAN
Ecological performance record (PER)-cropping farm with livestock and pig farming. The farmer (UD), the farm manager and contractor apply minimal tillage, and produces fodder cereals, grain maize, and sugar beet. He does not plough since 1997 and does not use any glyphosate since 2011. His land consists of 67 ha totally, 53 ha as arable land and 11 ha as permanent pasture with green manure.

CULTAN: Manuring, Nitrogen fertilization applied into the soil. Punctual fertilization and not spreading the fertilizer all over the soil (Ammonium nitrate sulphate, liquid)

Mineral: Mineral conventional manure (Lonza Sol N); Nitrogen fertilization with spreader; 80% pig manure and 20% Lonza-Sol N (Lonza-Sol N: 9.8% as ammonium-N; 9.8% as nitrate- N; 19.5% as urea-N).

Different fertilization techniques are applied next to each other in order to compare their impact on nitrogen losses (emission in the atmosphere or leaching in the groundwater), the accessibility of nutrients for crops, the nutrients uptakes by the plants, the diversity of the microbial community, and the crop quality and yield:

- UDK1: Organic manure; mixture of 2/3 of pig manure and 1/3 of cattle manure; Organic manure: 1.9 kg N·m-3, 1.9 kg P·m-3, 2.4 kg K·m-3 Applied with drag hose technique.
- UDK2: Mineral fertilization; mixture of 80% of pig manure and 20% Lonza-Sol N; Lonza-Sol N: 9.8% as nitrate-N; 9.8% as ammonium-N; 19.5% as urea-N Applied with centrifugal spreader (surface application).
- UDE: CULTAN fertilization; AMS liquid fertilization;
  AMS: ammonium sulfate (NH4)2SO4; 21% as NH4-N; 24% as SO4-S
  Applied with CULTAN. The NH4-fertilizer is placed in highly concentrated depots in the soil.

The amount of fertiliser was calculated to reach a total of 145 kg/N per ha as

target, including initial fertiliser and farmyard manure.

Key parameters

- Reactive nitrogen emission (Nr): ammonia (NH3), nitrous oxide (N2O) and leaching of nitrates (NO3-).
- Consumption of ammonium (NH4+) with time by the crop and soil microorganisms (15N isotope). Be careful at the isotopic fractionation of N during the nitrification process
- Microbial activity
- Nutrient uptake by the plant (N, P, K, C, micronutrients).
- Protein content
- Crop yield, number of plants per m2, number of spikes per m2, number of grains per spike, 1000 grain weight.
- Microbial biodiversity, mycorrhizal health and diversity.

SICS 3 – GREEN MANURE REMAINING ON SOIL

The main objective of the experiment is to compare the effects of glyphosate use to destroy the green manure applied in the field resulting to bare soil in comparison with green manure staying in the field. The experiment was established in June 2018 and was set up in control versus treatment (elementary) experimental design. The treatments are replicated three times in two different experimental fields.

The experiment is conducted on two farm fields which are managed by farmers. The first field close to Ellikon an der Thur, Switzerland (UNIBE_FD5 in the database) is located at an altitude of about 403m and covers an area of about 16400 m^2.

Control: Conventional agriculture. Green manure and glyphosate.

SICS: Green manure (intercropping), minimum tillage, reduced use of pesticides (no glyphosate, but with fungicides)

Green manure:

Field 1: Yellow mustard;

Field 2: N-MAX T (Large-seeded legumes, sunflower, phacelia, oats. Produce a large biomass and fixe nitrogen).

Field operations

The management operation in the fields include minimum tillage (disk harrow at 5 cm), and crop rotation. In the FD5 the main crops were: 2019: sugar beet, 2020: onions. For FD6 the main crops are: 2019: sugar beet, 2020: potatoes. The green manure included the following corps: Large grain legumes, sunflower, phacelia and oat. Different fertilizers are applied to both fields as well as several chemicals (pesticides, insecticides etc.)

according to the needs. The responses to the questionnaire distributed to the participants are as follows:

Have you participated in any of the previous workshops?

Yes: 87.5%
No: 12%

Are the results of the project plausible and / or are they in agreement with your understanding?

Yes: 95%

No: 5% (explained by the fact that some results are not significant).

How could you use the results of this project in your work (specify which results can be used and in what ways)?

Based on the clustering, the technics used in general can be promoted within the farmers associations with regard to the similar conditions during workshops.

Gained knowledge from SoilCare can be promoted and disseminated within scientific community.

CULTAN has almost the most impression. More information on the machine used should be provided as well as its availability in the region under consideration.

CULTAN has the potential to widely be used if the organic fertilizer can be integrated.

How can we disseminate the knowledge acquired through the SoilCare project so that it could benefit more people (how could you help)?

Through farmer associations during workshops.

Leaflets and brochures can be distributed by the farmer adopting the practices to other farmers during occasional events.

Dissemination of the results in national and international journals.

Adverting information to technicians, farmers and students of agricultural schools. Publication on websites destinated to consumers.

Promotion by companies with interest on sustainable agriculture (BioSuisse). Universities and high schools for learning.

What benefits have you gained from SoilCare?

Knowledge regarding soil fertilization. Innovative practices such as CULTAN.

Green verges are efficient against soil compaction.

Sharing knowledge and resources regarding the new techniques.

How would you like to be supported in the use or implementation of project/research results?

Through availability of knowledge and easy access to it. Availability of skills and machinery.

Exchange with farmer adopting the practice. Through exchange with technicians.

Promotion of the advantages of the practices.

Name one thing you wanted to remember or one thing you wanted to do with what you have learned from SoilCare.

The application of CULTAN is an interesting practice and should be promoted further.

Green manure is largely used in agriculture. The technique presented (SICS 2) to reduce glyphosate should be more promoted within conventional farming.

Promote the use of green manure to decrease the use of glyphosate. Fertilization through organic manure.

What are the barriers for implementation of the SICS?

Knowledge is needed for implementation, example CULTAN needs information on the amount of fertilizer and its depth and time of application to be efficient.

Some procedures are not simple such as green verges used in SICS 1. More information on this technic is needed.

SICS 1 needs a large area to be applied at the field scale (Note that the agricultural surface areas are restricted in Switzerland). The farmer using this technique has relatively large surface area, which is not the case for the majority of the farmers in the region. The adoption of the SICS 2 (green manure permanently kept on soil surface) as assessed here needs two main challenging issues to address (i) inform the farmer about the impact of using pesticides on environmental, animal, and human health, and (i) support financially the farmer for the complete transition.

UK

UK final stakeholder workshop

Introduction (0.5-1 page)

Stakeholder workshop by Zoom and Miro 16 December 2020

The purpose of the workshop was to obtain feedback on the SoilCare research results from the wider stakeholder group, including those working directly with farmers, and those concerned with wider societal objectives for flood risk management and water quality.

Factsheets presenting the results of the experiment were circulated to participants a few days before the workshop. We provided a 10 minute Powerpoint presentation of the results, focusing on those that were most relevant and meaningful for our site and the local area. The Miro board was set up before the workshop and participants were asked to log in to it and even make initial contributions if they wished to do so before the meeting. Some participants were reluctant to use the Miro, but we have done our best to capture points raised in discussion and on the Miro board. Participants were asked to identify themselves with initials or names when commenting on the Miro board, but many comments were made anonymously. At least one potential participant indicated that he was uncomfortable using Zoom and did not join the workshop. However, the following participants attended and contributed to the discussion.

Representatives (and gender m/f)
Anglian Water f
Natural England m
Environment Agency (national) m
Environment Agency (local) m
National Farmers Union m
Hutchinsons (agronomist) f
Welland Rivers Trust m
River Nene Regional Park f
GWCT Researcher f
GWCT Researcher & Facilitator m

Discussion of project findings (4-6 pages)

I) Compaction alleviation

The research findings were summarised in the factsheet as:

- Water stable aggregates were slightly improved by AMF inoculation. Fungi are known to stick aggregates together, so inoculation appears to improve soil structure, although very moderately.
- Earthworm numbers were consistently lower in the two cultivated plots. This supports previous research which found that ploughing reduces earthworm populations.
- CO_2 emissions were higher, and N_2O emissions were lower, in the plots with physical compaction alleviation than in the AMF and direct drill only plots.
- If there is a compaction problem, direct drilling without alleviation will result in a yield penalty.

The factsheet also included a graph which showed that subsoiling was at least as profitable as ploughing as a means of alleviating soil compaction, and that direct drilling in the presence of compaction had an economic penalty, while use of the inoculant had a small net cost.

In the presentation, more was made of the data collected on greenhouse gas emissions associated with the management practices as this has been a unique focus for our site and revealed new and very informative results. Under compacted conditions, N2O emissions from uncultivated soil are higher in winter than from ploughed or subsoiled soil. Taking into account both N2O and CO2, the net global warming potential of all management practices is roughly equivalent.

- Discussion of research findings: Summarise key discussion points, based on a) the discussion immediately after your presentation; and b) the validation post-it exercise in which you asked if findings were in line with the understanding of participants (1 page)

The following comments were made by participants:

On presentation of the results

NFU – need to specify problem of soil compaction on clay soils more explicitly so that the rationale for the research is clear.

? - Results show that subsoiling where needed is just as profitable as ploughing so that's good news. However, what about in late harvested root crops going into wheat. I wouldn't say people would just subsoil those fields; they would most likely plough despite it affecting earthworm numbers, so maybe there is awareness of context when presenting the results e.g. ploughing sometimes is not avoidable depending on rotation. Root crops are profitable on the main so is it more about how to farm root crops with minimal soil damage would be a good further study?

? - It would be useful to see costs/ha for the different treatments. Information is very interesting but it's challenging to present it in a lightweight manner. Could the 2nd page with the figs 1-5 be laid out differently?

NFU – For farmers, is the language right?

- The information is useful but had to be read through several times to get the key points.

? – As a layman, I had to read it several times to get my head round some of it, so agree with NFU.

From these comments, we conclude that we need to be clearer about the objectives of the experiment. It is designed specifically to test the effect of different approaches to compaction alleviation in a no-till system on clay soils. The issue of root crops would not then arise for example. We also need to make more of the economic results, identify why some of the metrics are relevant to farmers' objectives, and express this in a language that is accessible to them.

On the results themselves

Anglian Water - would the same responses be visible within the tramlines between plots?

Environment Agency - it would be good to see the carbon cost from operating the machinery across the different plot treatments.

? - Interesting that moving soil via reducing compaction has lower NxO emissions than control or AMF situation – this was new.

Anglian Water – I was surprised that AMF made a difference as although theoretically from reading around it does, I had not seen in the field trial results to show that. Interesting results. is investing in AMF worth it?

? - Results broadly as one might expect with a prior understanding of the processes but the N2O flux came as a surprise.

? - is the study long enough, 2 years seems a very short time to measure the pros and cons between methods for yield? What cultivation costs were used? Surprised that the margins are not more.

Compaction would be higher in tramlines, with associated implications. The issue of being unrepresentative by compacting the entire plot was raised by a previous farmer group, but was necessary for research purposes to enable data collection.

The economic analysis shows that the AMF inoculant has no economic benefit.

Both the government and NFU have set targets for climate change objectives and participants recognised that our results were relevant to this, but as one pointed out, are just one part of the larger picture for crop establishment which needs to include emissions from diesel use in field operations.

The comment about the duration of the study is relevant as the research would be more meaningful if carried out across at least a whole rotation.

- Impacts that have happened (1-2 pages):
    - Identify any benefits that have already arisen from the "usefulness" post-it note exercise, in which you asked how participants could use project findings (where possible group similar ideas together, providing a summary of the ideas in your own words, followed by examples of the specific suggestions made on post-its, in English, as a bullet-point list under each of your summaries)
    - Identify additional benefits that have already arisen from the second post-it exercise where you asked "what benefits have you gained from SOILCARE already"

Participants struggled to identify specific benefits to them arising from the SoilCare project to date as results from the project are only now becoming available to them. However, they continue to be supportive of it and keen to discuss where results are useful to their objectives and how these results can best be disseminated to the relevant audience, as outlined below.

- Future impacts (1-2 pages):
    - Collate the remaining points from the "usefulness" post-it note exercise, grouping similar ideas together (as described above)
    - Summarise the post-its arising from the questions, "How could we get our findings to more people who can benefit from them?" and "How would you like to be supported in using or implementing project/research findings?", providing summaries in your own words with illustrative examples from the post-it notes in the words of your participants (translated to English)
    - Add any impacts mentioned in the final feedback exercise on postcards, the round-robin or post-it exercise, depending on which option you selected

NFU – Results should be made available to members in the Welland but …
- results need to be communicated with people that are on the same soil types, which largely cover the Welland and the Nene catchments upstream of the A1.

Anglian Water – this should be summarised and included in local newsletters. The theories behind reduced cultivation are known to farmers but we still need to work to encourage changes in practice. Could we get a local farmer that is succeeding with no plough to act as an ambassador and discuss with others at a workshop?

Environment Agency – getting metrics on what this means for reductions in runoff and increases in infiltration at a larger scale would be very useful to answer questions from higher powers…!

NFU – the lowest tier of ELMS is the Sustainable Farming Initiative (SFI). Results shown here will be helpful in ensuring farmers approach soil structure and health measures in the right way.

Anglian Water – Link to 'Cultiv8' event in Peterborough. Combine with other speakers – someone doing it well.

Anglian Water – Many ways include relevant newsletters to local farmers, perhaps link to BASE and present at one of their meetings, Cultiv8?

? - Do we have a precedent of providing lay summaries of our research to more widely read publications such as Farmers Weekly of farming UK? Factsheet seems a bit heavy for the lay person but messages are important.

There was broad agreement amongst participants that there was a need to make the objectives clearer (specifically compaction alleviation in direct drilled system on clay soils), make more of the economic results, and simplify the language to appeal to farmers. The EA and wider stakeholder less directly involved with farmers placed more emphasis on societal issues such as water infiltration and GHG audit of the system as a whole.

II) Deep-rooting grass ley cultivars

The research findings were summarised in the factsheet as:

- In unharvested plots, Fojtan had significantly higher root volume at depth than the control and Donata
- Less intensive harvesting and lower associated compaction may increase the potential for reduced flood risk through Fojtan root growth
- Fojtan and Donata are as productive and palatable to weaned lambs as a conventional ryegrass and clover ley
- Cutting and grazing the forage create soil compaction and reduce root growth and the soil's ability to absorb water
- Using Fojtan could contribute to flood risk management if combined with low intensity harvesting

- Discussion of research findings: Summarise key discussion points, based on a) the discussion immediately after your presentation; and b) the validation post-it exercise in which you asked if findings were in line with the understanding of participants (1 page)

The following comments were made by participants:

On presentation of the results –

Environment Agency – more information needed on infiltration – changes in runoff associated with changes in management.

Environment Agency – Be useful to EA to know actual infiltration rates difference between low intensity grazing and usual grazing. Could do with a more applied understanding of this, i.e. what does it mean in volume of run-off per hectare reduction?

? - Page 2 fig 2. Penetration resistance vs forage cover – would the axes be better the other way round?

On the results themselves –

NFU – Information very relevant to land use change in the Welland as it is a mixed farming area.

Natural England – Need to understand more about grazing pressure on different grass species. The results provide evidence for a need to introduce an agri-environment scheme option reducing grassland management intensity.

Environment Agency – a longer term data set would have been good.

? – shows that traditional sward mixes are just as good as other mixes.

Anglian Water – Plausible if disappointing results as in theory it looked like it should work? Maybe the breeding was done in absence of livestock. E.g. plots so doesn't represent real world. Would be interesting to do study of livestock farmers who have used different sward mixes to see which species they would recommend.

? - Disappointing results on the whole and not practical in a productive farming system – how does penetration resistance and infiltration vary across plots under varying levels of antecedent soil moisture?

It is interesting that some participants interpreted the results in such negative terms, while others felt the impact of harvesting was an important and useful finding, but it is not possible to attribute all comments to the individuals concerned because they did not always identify themselves on the Miro board.

Impacts that have happened (1-2 pages):

- Identify any benefits that have already arisen from the "usefulness" post-it note exercise, in which you asked how participants could use project findings (where possible group similar ideas together, providing a summary of the ideas in your own words, followed by examples of the specific suggestions made on post-its, in English, as a bullet-point list under each of your summaries)
- Identify additional benefits that have already arisen from the second post-it exercise where you asked "what benefits have you gained from SoilCare already"

Participants struggled to identify specific benefits to them arising from the SoilCare project to date as results from the project are only now becoming available to them. However, they continue to be supportive of it and keen to discuss where results are useful to their objectives and how these results can best be disseminated to the relevant audience, as outlined below.

Future impacts (1-2 pages):

- Collate the remaining points from the "usefulness" post-it note exercise, grouping similar ideas together (as described above)

- Summarise the post-its arising from the questions, "How could we get our findings to more people who can benefit from them?" and "How would you like to be supported in using or implementing project/research findings?", providing summaries in your own words with illustrative examples from the post-it notes in the words of your participants (translated to English)
- Add any impacts mentioned in the final feedback exercise on postcards, the round-robin or post-it exercise, depending on which option you selected

Anglian Water – Promote results through British Grassland Society, and locally through Welland farmer newsletter.

Anglian Water – Report back to the grass breeders of findings to inform future breeding? Link to BSPB or present at BPS meeting. Link with British Grass land Society – perhaps do an article? Locally, highlight in Welland farmer newsletter to livestock/mixed farms.

Anglian Water – An event or demo is needed to make it meaningful to farmers. Make more on economic data

NFU – Identify the win wins arising from the research.

? – Could this be useful with changes to grazing regimes that are trialling mob grazing? It does however open a new question that was not approached in the method.

? – Possibly useful in steering the conversation with grass breeders. Useful data to be provided in the planning of future stewardship options, if only to show what doesn't work.

Note that no economic data were collected for this experiment as the cost of establishing each of the cultivars tested is the same.

The possible lack of attention in plant breeding trials to practical end use of the sward, and more specifically to ecosystem service objectives is in line with our own thinking as researchers.

As our research is normally concerned with arable systems, this experiment opens up opportunities to engage with a wider audience, including livestock farmers and mixed arable and livestock farmers, and plant breeders, as well as policy makers in terms of the ecosystem services that might be provided through agri-environment schemes and similar initiatives.

Note:

- When reporting on stakeholder's views/answers to the questions above, if possible mention whose views you are reporting e.g. farmers, advisers or policy makers, men or women, and indicate where there is consensus or disagreement.
- Where specific issues are raised by women, please identify these

- Please try to capture the take-home message by each stakeholder about making sustainable soil farming practices more diverse and inclusive (gender, age-younger people)

Appendix

- Final fact sheets used in the workshop, in English, incorporating any changes you made from the version sent to you by WP leaders.
- Optional: additional details on study site research findings e.g. a PDF of PowerPoint slides as a handout with 6 slides per page

Note: this final stakeholder workshop replaces your Year 4 Multi-Stakeholder Advisory Panel (MSAP) but you are welcome to have more than one stakeholder workshop if you (and/or the stakeholders) want. For any additional stakeholder interactions, please use our online reporting form.