SoilCare
SOILCARE FOR PROFITABLE AND SUSTAINABLE CROP PRODUCTION IN EUROPE

Report on the selection of good policy alternatives at EU and study site level

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Report number: **13**
Deliverable: **D7.2**

Report type: **Scientific Report**
Issue date: **August 2021**
Project partner: **Milieu Consulting SPRL**
Version: **V3.0**

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DOCUMENT SUMMARY	
Project Information	
Project Title:	Soil Care for profitable and sustainable crop production in Europe
Project Acronym:	SoilCare
Call Identifier:	H2020-SFS-2015-2b
Grant agreement no.:	677407
Starting Date:	01.03.2016
End Date:	31.08.2021
Project duration	66 months
Web-Site address:	www.soilcare-project.eu
Project coordinator:	Wageningen Environmental Research (WEnR)
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Report Information	
Report Title:	Report on the selection of good policy alternatives at EU and study site level
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Deliverable Number:	D7.2
Work Package:	WP7
WP Leader:	Milieu Consulting SPRL, Belgium
Nature:	PU
Dissemination:	Document
Editor (s):	Rudi Hessel
E-Mail(s):	rudi.hessel@wur.nl
Telephone Number(s):	+31 317 486530
Report Due Date	01-03-2021
Report publish date:	V1: 15-03-2021; V3: August 2021
Copyright	

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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
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Deliverable 7.2

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FINAL, August 2021

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Executive summary

There is a growing consensus that agricultural practices in Europe must change to remain both profitable and sustainable, something which is also reflected in numerous policy initiatives at the European level over the last decade which directly or indirectly promote existing beneficial agricultural practices. Most recently, the European Green Deal sets out the roadmap for making the EU's economy sustainable and sets out several key actions which will be crucial in advancing land and soil protection in Europe.

With this shift comes increasing pressure on agricultural producers to change how they operate and adopt new techniques and practices, not only due to the described changes in policies, but also their own environmental concerns, private industry standards, and increasing consumer awareness. However, innovation associated with potential benefits to soil quality are not yet adopted to their full potential and are in some cases even abandoned, raising the question of why support and adoption of these practices by European farmers is still considerably weak.[1]

Based on the analysis of the policy framework at EU, national, and sub-national level, and feedback collected from European and national stakeholders, we can formulate a set of overarching recommendations for actions to facilitate the wider uptake of SICS across Europe.

The work presented in this report was carried out as part of the EU-funded SoilCare project[2]. The overall aim of SoilCare is to identify, evaluate and promote promising soil-improving cropping systems (SICS). SoilCare defines SICS as specific combinations of crop types, crop rotations and management techniques aimed at halting soil degradation and/or improving soil quality cropping systems that improve soil quality (and hence its functions), and that have positive impacts on the profitability and sustainability of agriculture.[3] Such cropping systems have then been tested in 16 study sites as part of the SoilCare project, located in both EU and non-EU countries.

Recommendation I: Define long-term ambitions and targets

Develop long-term strategies for sustainable agriculture: strategic vision going beyond short-term political interest has great potential to facilitate a transition to sustainable agriculture and thus better soil management practices. In the same vein, policies should aim to be more holistic and include long-term targets considering the long timeframes often needed for benefits to materialise (especially when looking at soil health impacts).

At the EU level, the European Farm to Fork Strategy provides a starting point for developing such a vision at European level.

At the country level, key aspects of the Farm to Fork strategy could be further developed and

[1] e.g., Lahmar, R. 2010. Adoption of conservation agriculture in Europe: Lessons of the KASSA project. *Land Use Policy* 27(1): 4-10.
[2] SoilCare: Soilcare for profitable and sustainable crop production in Europe, https://www.soilcare-project.eu/
[3] See also https://www.soilcare-project.eu/images/WPs/WP2/Non-technical_summary_of_Soil_Improving_Cropping_Systemsshort_version.pdf

adapted to create a national vision for sustainable agriculture with key steps developed to meet these ambitions. National processes for implementing the Agenda 2030's Sustainable Development Goal could further provide a formal framework for formulating such a vision.

Raise and clearly define the level of ambitions in existing policies

There is a historical lack of ambition regarding policy targets and measures, especially in the CAP, which is further undermined by a lack of rigorous implementation. This includes inter alia incentives such as hectare-based payments under Pillar 1 that derive unintended consequences with respect to other policy objectives since payments should be based on performance against clearly defined objectives delivering from, among others, soil benefits.

The new CAP does not remove hectare-based payments but does try to increase the ambition by introducing enhanced conditionality and eco-schemes. However, there is still little emphasis on the monitoring of environmental benefits. Providing more flexibility to Member States, as the 2018 CAP proposal envisages, to define their own targets is potentially beneficial to the design of context-dependent measures, however, the lack of clearly defined objectives undermines the ambition required from the CAP. Furthermore, it is up to each individual Member State to define their level of ambition with respect to budgetary reallocation towards eco-schemes which will come from the same Pillar 1 budget.

At the country level, Member States are encouraged to take the opportunity of designing eco schemes that clearly go beyond cross-compliance to meet environmental targets. In addition, contracts provided for farmers (under RDP measures or the new eco schemes) should cover longer time periods to provide more stability for farmers. This also applies to the design of funding schemes which would allow farmers long-term planning.

Define binding soil targets and promote sustainable practices through either dedicated soil policies or mainstreaming of soil objectives in existing and new environmental/sectoral policy instruments

Soil has re-emerged as a high priority at EU level with the development of a new EU Soil Strategy on going, however, in the absence of a Soil Framework Directive, the protection, maintenance, and improvement of land and soil at EU level as well as in the countries covered by this study relies heavily on sectoral and environmental policies. Furthermore, not all soil threats are equally well targeted by existing instruments. While this is not necessarily a barrier to SICS adoption, there is a risk that key soil threats are not addressed if they do not fall under legislation for other sectors. In addition, analysis of the benefits of these SICS in relation to the existing policy framework at European level shows that many of these approaches can actively contribute to meeting the objectives of EU legislation. Our research also demonstrates how SICS may play a part in reaching the Sustainable Development Goals.[4]

[4] See SoilCare Policy Brief "Soil health policies towards Sustainable Development Goals, available at: https://www.soilcare-project.eu/resources/resources-for-policy-makers/42-resources/236-policy-briefs

At the EU level, actions could include:

- Developing specific targets for different pressures affecting soil functions/causing soil threats for integration in new policy initiatives, such as the ongoing revision of the Soil Thematic Strategy, the planned Zero Pollution Action Plan, and the upcoming Nature Restoration Targets.
- Build on the SDGs, particularly target 15.3 which establishes the objective of land degradation neutrality by 2030.
- Promote SICS through relevant strategic and sectoral policies, including the new Soil Thematic Strategies, EU-level advice on Eco Schemes as well as Commission recommendations issued to the Member States within the context of the formal review and approval process of the new Cap Strategic Plans.

At the country level:

- Relevant SICS could be incentivised through measures in the CAP Strategic Plans, and particularly the Member States' Eco Schemes.
- Stakeholders, particularly farmers should be involved in the development of national and sub-national policy instruments. The Farm to Fork Strategy explicitly calls for strengthening the position of farmers in the supply chain, and the procedures for drafting national CAP Strategic Plans ask for a wide consultation process.

Recommendation II: Increase coherence and exploit synergies between policies more effectively

Different priorities put forward by targeted policies over time can create undesirable effects which are sometimes difficult to remedy. In this regard, greater horizontal integration of policies would allow the trade-offs between policy objectives to be exposed and limit the potential for perverse policy outcomes to emerge.

There are many different pieces of legislation which can work better together if coherence and integration between them is improved: Cross-compliance addresses soil quality through GAECs which are not necessarily integrated with other cross-compliance measures such as the Statutory Management Requirements related to the Nitrates, and Birds and Habitats Directives. In addition, stakeholders noted that some soil-improving practices might not align with existing policy objectives.

At the EU and country level,

- Policy conflicts and synergies need to be carefully analysed and aligned, so as not to discourage the transition to sustainable farming practices. The new CAP proposes changes to improve the overall coherence of CAP with other, but mainly environmental legislative instruments. Potential conflicts with other sectoral legislation remain.
- Mechanisms to ensure coherence between different legislation and policy can include future looking impact assessment which integrates soil health as a fundamental

element. This means all relevant legislation would go through a set of criteria to determine whether they have an adverse impact on soil either directly or through encouraging unsustainable farming practices. Such a mechanism would recognise the cross-cutting nature of soil as a mediator of multiple land-based services, providing higher consideration in policy evaluation.

- On a practical level, it is important for farmers to have clear, unambiguous information on the legal conditions they need to comply with – especially if they are tied to subsidies - and those that may be rewarded.
- A two-way communication between the policy makers, the farmers and the neutral advisory services would help to create a constant feedback loop, overcoming some of the clarity issues and avoid top-down policy design. Permanent platforms for exchange involving diverse representatives of farmers, other actors and policy makers can be envisaged both at EU and country level.

Recommendation III: Design targeted (economic) instruments that facilitate a transition to sustainable practices and reward environmental benefits delivered

Stakeholders noted that the CAP, as the financial instrument shaping farming across Europe, should strive to be less prescriptive, avoiding one size fits all approaches but provide the farmers with a general direction, clearly defined by targets and empowering them to take steps towards these targets in a way that is best adapted to their unique circumstances.

At the EU level, the new set-up proposed for the post 2020-CAP give Member States a higher degree of freedom when it comes to defining the new CAP Strategic Plans.

At the country level,

- Member States should ensure that financial instruments facilitate the transition to long-term change in practices rather than finance one-off interventions. Grants should be made available to farmers (or groups of farmers) buying new equipment to implement sustainable practices.
- There is a need to consider the different conditions in which farmers operate (such as differences in tenure). Furthermore, incentives must be adapted to changing conditions such as inflation, so they do not lose their attractiveness over time.
- Measures need to be flexible enough to allow for regional differences. A financial measure on cover crops may well be appropriate in one part of a country, but less appropriate in another. Financial incentives need to be more targeted, both tied to specific actions and region (or environmental/geographic conditions) to result in the desired change.
- Priority should be given to regionally prescribed SICS that are able to be a source of food production that is both profitable and sustainable. Soil is cross-cutting in nature as a mediator of multiple land-based services and therefore, the impact on soil should

be a higher priority in any policy evaluation.

- Funding should be easily accessible by simplifying the application process. The payment agencies should seek to simplify procedures for farmers applying for CAP payments in order not to deter farmers from adopting SICS. However, control mechanisms and monitoring must be robust to prevent abuse.
- In addition, market instruments can be used to counter the impacts of the current food production systems which prioritise short-term economic gains. Taxation for unsustainable products and techniques at consumer level is a way of internalising the costs on the environment and wider society and would also influence consumers' choices, creating more demand for sustainable products, giving them the price advantage.
- Non-financial economic instruments are also important and should be taken into account when designing policy. For instance, schemes for sharing equipment and/or collective buying which would be otherwise expensive can be created, encouraged and promoted among the farmers. Stakeholders from the industry can be encouraged to take part in these schemes to promote their equipment/material.

Recommendation IV: Strengthen monitoring and enforcement

It is acknowledged that whilst the CAP has the potential to deliver real impacts, it is undermined by a lack of proper implementation, control, and sanctions or penalties for non-compliance.

- At the EU level, there is a need to establish a clear, robust, and reliable policy monitoring and enforcement system for the CAP. Whilst the new CAP proposal includes a detailed set of indicators, they mainly focus on establishing target areas/proportions which should be covered by a specific measure rather than define environmental improvements that should be achieved at the level of individual agricultural enterprises. Another important feedback involves streamlining different monitoring systems set up for different legislation. To create integrated systems for these separate processes can greatly enhance reliability and reduce administrative burden on public authorities.
- At the country-level, stronger monitoring and enforcement systems require the training of farm inspectors who, like farmers, need to understand the regulatory requirements and their practical implementation. Additionally, stakeholders acknowledge the potential benefits of a dedicated unit within the governments specifically focusing on monitoring soil health. This should be accompanied with sufficient resources for operation and enforcement.

Recommendation V: Strengthen existing and establish new opportunities for learning and knowledge exchange for farmers

Financial incentives such as those established by the CAP may be less effective than other types of instruments such as provision of information and advisory services, as they do not consider factors relating to farmer views and attitudes. Personal convictions of farmers play a key role

in the adoption of new practices, and information and educational measures are therefore key to facilitating a transition to agricultural practices that benefit soil health.

Strengthen the capacity of Farm Advisory Services: Farm Advisory Services are valuable sources of information for the farmers, but their independence and neutrality should be ensured. Like farmers, advisors also need to learn about new practices, their practical application, costs, and benefits to support farmers they assist.

Support of Fam Advisory Services, e.g., though CAP instruments, therefore, needs to continue. At country-level, technical skills of farm advisory services need to be strengthened through governmental support to ensure that the advice delivered reflects current knowledge and remains impartial.

Inform and educate farmers about new developments and insights. Dissemination of knowledge, awareness raising, and education are important components of policy interventions, and they should be used in parallel with economic and legislative instruments.

At the country level,

- Make soil health a stronger component of vocational training and continued education of farmers. The move from conventional practices to SICS and sustainable agricultural practices requires a shift in attitudes as well as knowledge. Soil, as the main medium on which food and feed are grown, should feature highly on the curriculum for farmer training, be it basic vocational or continued adult learning. It should also underline the basic principles of sustainability such as generational fairness, the importance of soil health for all other systems on the planet and the impacts of unsustainable practices.
- Establish regular training; informative sessions on latest innovations are preferred to one off training sessions which have limited impact. Some of the practices benefitting soil will require farmers to learn about these techniques, their application to different conditions as well as their benefits in order to change any misconceptions about these methods. Stakeholders suggest that well-organized and continuous interactions with farmers such as free group talks are successful in bringing change in attitudes and beliefs.
- Engage with farmers and trusted organisations to deliver advice and training. Peer to peer learning and bottom-up initiatives are powerful tools to deliver knowledge to farmers as they put a great degree of trust in their fellow producers. Partnering with farmers willing to pioneer new techniques or trusted organisations, will ensure that target audiences are reached, and new information is heard.
- Collaborate with scientists and other researchers to promote innovation which would optimise technologies to allow farming to become more sustainable across the board and to make research findings accessible and ensure their wide dissemination
- Disseminate knowledge via multiple channels, through the provision of guidance document but also through farms visits and demonstration days. A recurrent

suggestion is to identify lighthouse projects and disseminate them across a wider community of farmers.

- Consider the establishment of a network of model farms demonstrating how to use and adapt different SICS in the region.
- Engage with a wide demographic, ideally using tailored methods for delivering advice. Younger farmers seem to be willing to take up new practices, and it is important to reach older generations as well.

Information and knowledge shared should:

- Explain the costs and benefits of new practices. The advantages and disadvantages of the soil-improving cropping systems trialled at the study site are poorly understood by farmers. They should be widely communicated, and ideally demonstrated with field visits, to farmers in the region, by the advisory services, farmers with first-hand experience with these techniques, and other organisations trusted by the farming community.
- Be coherent and clear and avoid giving conflicting and confusing messages.
- Provide up-to-date information on policy requirements and administrative procedures.

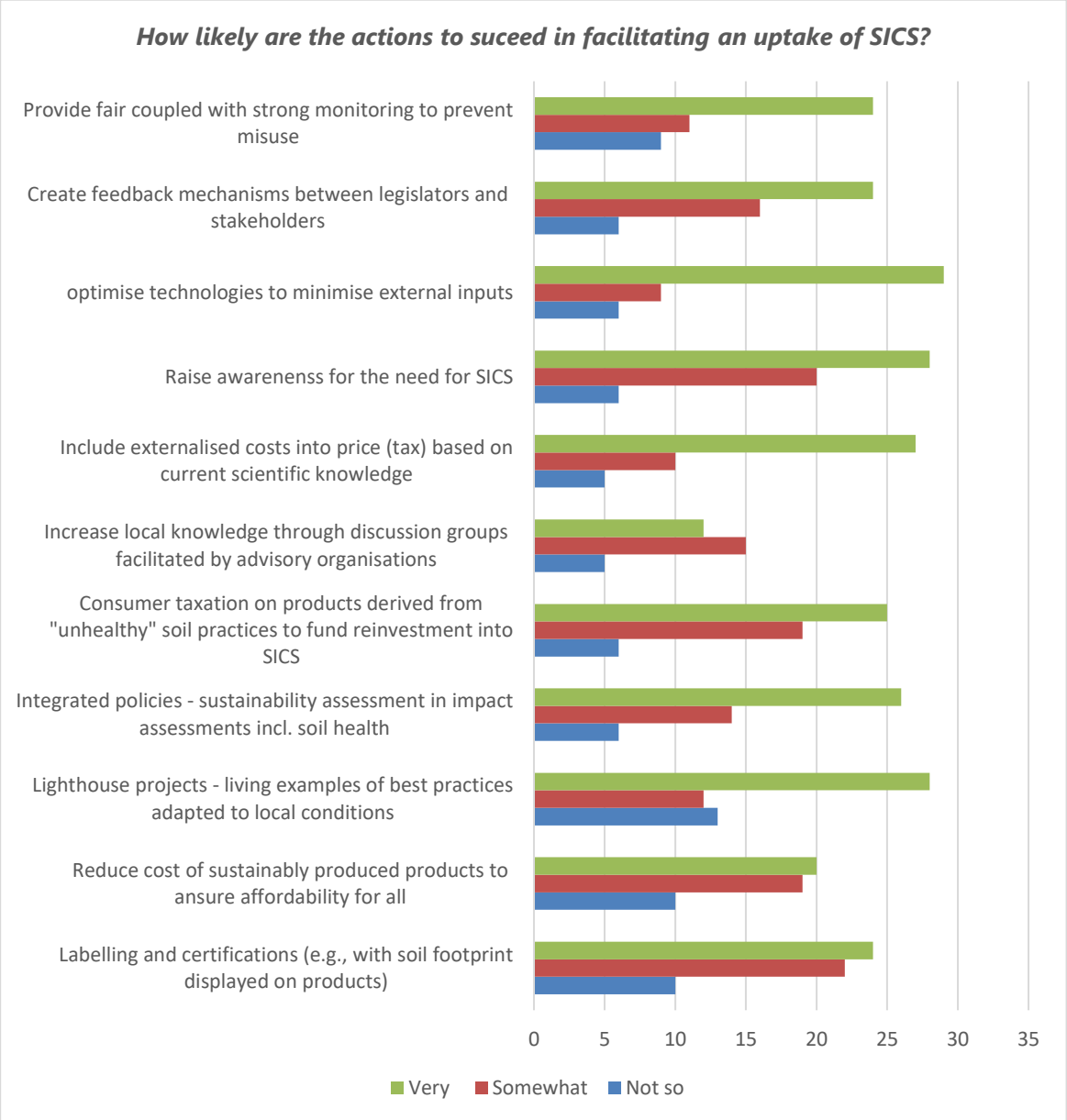
Finally, both at the EU and country level,

- Measures should be taken to educate consumers about the advantages and disadvantages of conventional farming practices vs. sustainable practices to ensure increased demand for sustainably produced products and encourage the retail sector to make these more widely available to all sections of society. Important points raised by the stakeholders include informational labelling schemes for products that are good for soil (informing customers how the product contributes to soil health or having a sustainability score). For such schemes, tracking and tracing of products can use available technologies already used for other purposes. Better promoting sustainable products would increase their market value and the customers' willingness to pay, leading to a fairer compensation for sustainable practices. This is especially important where costs of unsustainable production are not reflected in the consumer prices.
- An innovation award could be an effective instrument to create awareness for sustainable producers and production methods amongst consumers and farmers alike. To this end, cooperatives or producer associations play a major role in marketing these products, explaining production methods – especially important for practices such as sewage sludge application which might be perceived as a high-risk technique – and negotiating prices with retailers.

Box 1: Actions identified by EU stakeholders as most promising in facilitating a wider uptake of SICS

Priority actions identified by EU stakeholders

During an EU-level workshop, stakeholders were asked to identify the most important actions to overcome key barriers to the wider uptake of SICS. The graph below details the eleven actions stakeholders defined and how they assessed their likelihood of facilitating the uptake of Soil Improving Cropping Systems?



1 Introduction

In 2015 a comprehensive review of the state of the world's soils observed that most soils are in fair, poor or very poor condition, with 33% of land 'moderately to highly degraded'. This was reiterated in the latest report on the State of Environment in Europe, which states that both past trends and the outlook for 2030 regarding the condition of soil are deteriorating and the policy objectives for 2020 are not met[5]. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) states that 'avoiding, reducing and reversing land degradation is essential for reaching the majority of the Sustainable Development Goals and would deliver co-benefits for nearly all of them'[6]. Furthermore, in the wake of the COVID-19 crisis, the importance of soil in relation to food security and the overall well-being of human societies has become more prominent[7].

The most significant threats to the integrity and quality of Europe's soil resources have been previously identified as climate change, soil sealing, salinisation, compaction, acidification, chemical pollution, loss of organic carbon, and soil biodiversity as well as erosion[8]. Six of the soil degradation processes recognised by the European Commission's Soil Thematic Strategy (2006)[9] are closely linked to agriculture: erosion, organic carbon decline, soil biodiversity decline, compaction, contamination, and salinisation and acidification. There is a growing consensus that agricultural practices in Europe must change in order to remain both profitable and sustainable, something which is also reflected in numerous policy initiatives at the European level over the last decade which directly or indirectly promote existing beneficial agricultural practices. Most recently, the European Green Deal[10] sets out the roadmap for making the EU's economy sustainable and sets out several key actions which will be crucial in advancing land and soil protection in Europe: the Zero Pollution Action Plan for Air, Water and Soil (to be adopted in 2021) will address pollution of soil and land, while the Farm to Fork Strategy[11] establishes targets directly relevant for nutrient and pest management practices, integrated landscape management and organic production. In addition, the CAP proposal[12] for the next funding period expands the set of mandatory standards farmers need to comply

[5] EEA.2019. The European environment state and outlook 2020, available at: https://www.eea.europa.eu/publications/soer-2020
[6] IPBES. 2018. The IPBES assessment report on land degradation and restoration. Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany.
[7] FAO. 2020. Soil: the great connector of our lives now and beyond COVID-19, available at: http://www.fao.org/global-soil-partnership/resources/highlights/detail/fr/c/1298070/
[8] FAO and ITPS. 2015. Status of the World's Soil Resources (SWSR) – Technical Summary. Available at: http://www.fao.org/3/i5199e/i5199e.pdf
[9] COM(2012)046 final: The implementation of the Soil Thematic Strategy and ongoing activities. Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52012DC0046
[10] COM(2019) 640 final. The European Green Deal. https://ec.europa.eu/info/sites/info/files/european-greendeal-communication_en.pdf
[11] COM/2020/381 final. Farm to Fork Strategy, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0381
12 European Commission, Proposal for a Regulation of the European Parliament and of the Council on the financing, management and monitoring of the common agricultural policy and repealing Regulation (EU) No 1306/2013, June 2018; and European Commission, Annexes to the proposal for a Regulation of the European parliament and of the Council establishing rules on support for strategic plans to be drawn up by Member States under the Common agricultural policy, COM(2018) 392 final, June 2018

with[13], which could significantly benefit soil health.

With this shift comes increasing pressure on agricultural producers to change how they operate and adopt new techniques and practices, not only due to the described changes in policies, but also their own environmental concerns, private industry standards, and increasing consumer awareness. However, innovation associated with potential benefits to soil quality are not yet adopted to their full potential and are in some cases even abandoned, raising the question of why support and adoption of these practices by European farmers is still considerably weak.[14]

The work presented in this report was carried out as part of the EU-funded SoilCare project[15]. The overall aim of SoilCare is to identify, evaluate and promote promising soil-improving cropping systems (SICS). SoilCare defines SICS as cropping systems that improve soil quality (and hence its functions), and that have positive impacts on the profitability and sustainability of agriculture. Such cropping systems have then been tested in 16 study sites in Europe as part of the SoilCare project, located in both EU and non-EU countries.

This deliverable proposes a set of EU-level as well as national and regional policy alternatives and complementary actions aiming to promote the wider uptake of SICS. The work presented here builds on research carried out during the first phase of this project and which analysed the role, benefits and shortcomings of policies, policy instruments and practices as drivers for the adoption of soil-improving cropping systems.

The document is organised as follows:

Section 2 details the objectives and the methodology used to carry out the study.

Section 3 presents an analysis of the relationship between the SICS and European policy objectives. It first explores the ways in which existing policy mechanisms can support or incentivise SICS adoption, and then considers how SICS contribute to strategic and specific European policy objectives.

Section 4 describes the factors that influence the adoption of SICS in general, and the SICS tested in the SoilCare sites in particular.

Section 5 concludes with recommendations to further promote SICS using different policy instruments and conclusions.

The following Annexes are submitted with this deliverable:

- **Annex I**: Guidance for Adoption Workshop
- **Annex II**: Summaries of the country reports

[13] Through statutory management requirements (SMRs) and Good agricultural and environmental conditions (GAECs)
[14] e.g., Lahmar, R. 2010. Adoption of conservation agriculture in Europe: Lessons of the KASSA project. *Land Use Policy* 27(1): 4-10.
[15] SoilCare: Soilcare for profitable and sustainable crop production in Europe, https://www.soilcare-project.eu/

2 Research aims and methodology

SoilCare aims to identify, evaluate, and promote promising soil-improving cropping systems (SICS) so as to establish policy alternatives and complementary actions aiming to promote the wider uptake of SICS at EU, national, and regional level. **Error! Reference source not found.** below gives a brief overview of the groups of SICS identified as part of the project, as well as their impact on soil health.[16]

Table 1: SICS included in the study.

Soil Improving Cropping Systems (SICS)	Impact of SICS on soil health and other benefits
Crop rotation	Improves crop productivity, soil biodiversity and system sustainability; decreases need for pesticides and risk of erosion.
Green manures, cover crops, catch crops	Improves Soil Organic Matter (SOM) content, soil structure, soil biodiversity, nutrient use efficiency; decreases nutrient leaching, run-off, erosion.
Integrated nutrient management	Improves crop productivity, soil nutrient status and resource use efficiency
Enhanced efficiency irrigation	Improves crop productivity and resource use efficiency; minimizes risks of salinization and desertification
Controlled drainage	Improves crop productivity and resource use efficiency; minimizes the risk of waterlogging
Reduced tillage	Reduces energy cost and may enhance SOM content and soil structure; may increase the need for herbicides/ pesticides
Integrated pest management	Improves crop productivity and resource use efficiency; minimizes the loss of biodiversity.
Smart weed control	Improves crop productivity and resource use efficiency; may decrease the need for herbicides
Smart residue management	Reduces evaporation and soil temperature; may increase/decrease the success of germination
Controlled traffic management	Reduces energy cost and the risk of soil compaction
Integrated landscape management	Improves biodiversity and cropping systems sustainability

As part of the project, SICS have then been tested in 16 study sites located in both EU and non-EU countries.[17]

gives a brief overview of the experiments tested in each study site, identifying which group of SICS the experiment can be associated with. It also shows the aggregation of SICS into more

[16] SoilCare Deliverable 2.1 - A review of soil improving cropping systems, available at: https://www.soilcare-project.eu/downloads/soilcare-reports-and-deliverables/75-report-06-d2-1-a-review-of-soil-improving-cropping-systems-wenr-oene-oenema

[17] The 16 countries include 14 EU Member States, i.e., Belgium, Germany, UK, France, Czech, Poland, Hungary, Romania, Denmark, Sweden, Greece, Spain, Italy, and Portugal and two non-EU countries, i.e., Switzerland and Norway.

general "clusters" which were used for more high-level analysis, for example, when developing recommendations or comparing adoption factors.

Table 2: SICS components and clusters tested at the study sites. LTE: long-term experiment; CC: cover or catch crop.

Country, region[18]	SICS	SICS Cluster	Experiment
Belgium (BE) - Flanders	Reduced tillage, cover crops, integrated nutrient management, controlled traffic management	Fertilisation/Amendments	Organic soil amendments in wheat fields ("wood chips")
		Soil cultivation	Soil cultivation and soil cover in maize ("Grass undersowing")
		Soil improving crops	Novel crops- perennial wheat, soybeans, winter field beans, lupins (control: winter wheat).
		Compaction alleviation	Controlled traffic
Czechia (CZ) - Prague-Ruzyně	Reduced tillage, integrated nutrient management	Soil cultivation	Tillage experiments (LTE)
		Fertilisation/Amendments	Manure; catch crops and growing legumes
Switzerland (CH) - Frauenfeld	Controlled traffic management, integrated nutrient management, green manure, reduced tillage	Compaction alleviation	Grass verges + "control traffic"
		Fertilisation/Amendments	Under-foot fertilisation after Controlled Uptake of Long-Term Ammonium Nutrition (CULTAN) procedure
		Soil improving crop	Green manure and minimum tillage
Denmark (DK) -Viborg	Crop rotations, tillage, fertilization	Soil improving crops	CROPSYS crop rotations, organic and conventional / row cropping with catch crops
		Soil cultivation	CENTS / soil tillage intensities and cover crops: ploughed/harrowed/direct drilled, crop type, catch crop type, +/- straw
		Soil improving crops	Screening different types of catch crops
		Fertilisation/Amendments	Askov and Jyndevad / experiments with different levels of fertilisation and liming (LTE)
France (FR) - Brittany	Cover crops, reduced tillage	Soil improving crops	Early sowing of wheat (to reduce tillage in autumn)
			Cover crops (oat vs mixed)
			Interseeding cover crops in maize
Germany (DE) - Tachenhausen	Cover crops, reduced/no tillage	Soil improving crops	Reduced tillage with/without cover crops and with/without glyphosate application
		Soil cultivation	No tillage with/without cover crops and with/without glyphosate application
Greece (EL) - Chania, Crete	Cover crops, reduced tillage	Soil cultivation	No till in organic olive orchards; conventional till (15-20 cm) in organic olive orchards
		Soil improving crops	Conversion from orange orchard to avocado; conventional orange orchard

[18] In this context, regions are used to describe sub-national areas, particularly the area of the country where the respective study site is located.

Country, region[18]	SICS	SICS Cluster	Experiment
			Cover crop (vetch) in organic vineyards; bare soil in organic vineyards
Hungary (HU) - Keszthely	Crop rotation, reduced tillage, integrated nutrient management	Fertilisation/Amendments	Organic/inorganic N fertilization
			Mineral fertilisation in continuous maize cropping
			Organic/inorganic fertilization in different rotation
		Soil cultivation	Tillage in maize-wheat biculture
Italy (IT) - Legnaro	Reduced tillage, cover crops	Soil cultivation	Mouldboard plough and bare soil/ deep rooting cover crop
			No tillage and bare soil/cover crop
Norway (NO) - Akershus	Cover crops	Compaction alleviation	Biological compaction release (4 levels of compaction)
		Soil improving crops	Cover crop- Catch crop (CC)
			Precision agriculture (demonstration)
Poland (PL) - Szaniawy	Cover crops, integrated nutrient management	Fertilisation/Amendments	Soil management practices (Liming, cover crops, manure)
Portugal (PT) - Caldeirão	Crop rotations, cover crops, fertilisation	Soil improving crops	Bico da Barca - Organic rice in rotation with perennial lucerne
			Taveiro – Conventional grain corn in succession with legumes winter cover
		Fertilisation/Amendments	São Silvestre - Conventional grain corn fertilized by urban sludge
Romania (RO) - Draganesti Vlasca	Reduced tillage	Soil cultivation	Tillage experiments (ploughing and subsoiling)
Spain (ES) - Almeria	Cover crops, tillage, irrigation management	Soil cultivation/Soil improving crops	Regulated/deficit irrigation and minimum tillage Regulated/deficit irrigation and minimum tillage/cover crops Regulated/deficit irrigation and no tillage Regulated/deficit irrigation and no tillage/crop residues/cover crops
Sweden (SE) – Skane County, Southern Sweden	Sub soil loosening, tillage	Compaction alleviation	Sub soil loosening
United Kingdom (UK) – East Midlands	Crop rotations, tillage, fertilization	Compaction alleviation	Ploughing, subsoiling, and fungal inoculation (Compaction experiments)
		Soil improving crops	Introducing deep-rooting grass leys in rotation

This report is one of several deliverables produced under SoilCare. For more information regarding the project, please visit https://www.soilcare-project.eu/. On this website you will also find information on the study sites part of the project, as well as the selection and definition of the different SICS[19].

[19] https://www.soilcare-project.eu/soil-improving-cropping-systems/concept-of-sics

The rest of this section sets out the research objectives and methodology used to produce this deliverable.

2.1 Research objectives

The main aim of this report is to present good policy alternatives[20] at study-site and EU level to facilitate the adoption of soil-improving cropping systems. Identifying and designing policy measures to encourage farmers to adopt effective soil conservation practices requires first an understanding of common barriers to the adoption of soil improving practices, as well as an understanding of the policy context, and the way in which existing policy instruments support their wider uptake.

Key research objectives were thus formulated at the outset of the work:

A. To identify existing policies and policy instruments at EU-level as well as national and (sub)regional level in the 16 SoilCare study sites promoting soil quality, and particularly the adoption of soil-improving cropping systems.

B. To describe the intended mechanisms and impacts of existing policies, instruments, and practices.

C. To assess the extent to which existing policies, policy instruments and practices promote the adoption of soil-improving cropping systems.

D. To identify contextual factors, particularly institutional settings, influencing policy impact on farmer adoption.

E. To identify existing policies, policy alternatives, and complementary actions that could promote the uptake of SICS.

F. To assess the performance of good policy alternatives, their advantages, and disadvantages.

2.2 Methodology

The policy alternatives set out in this report were designed using a sequential research strategy with three data collection activities at the EU level and in the 16 European countries where the SoilCare study sites are located. Data was collected through the following activities:

1. A desk-study of policy documents and relevant literature;
2. Interviews with EU-level, national and regional policymakers and stakeholders;
3. A series of workshops at EU level and within the 16 SoilCare study site countries.

[20] Policy, loosely defined, is "officially accepted set of rules or ideas about what should be done" or "a system of courses of action with a common long-term objective (or objectives) formulated by governmental entities or its representatives" (see http://learnersdictionary.com/definition/policy and https://www.thefreedictionary.com/policy). Policy alternative or policy options refers to a set of different types of policy options including economic instruments, regulatory instruments, planning instruments and information/knowledge instruments.

Error! Reference source not found. outlines the overall study design and methods used to answer specific research questions. Whilst each data collection activity focused on a sub-set of the research questions, they are closely related, and the information gathered from each step was fed into subsequent steps.

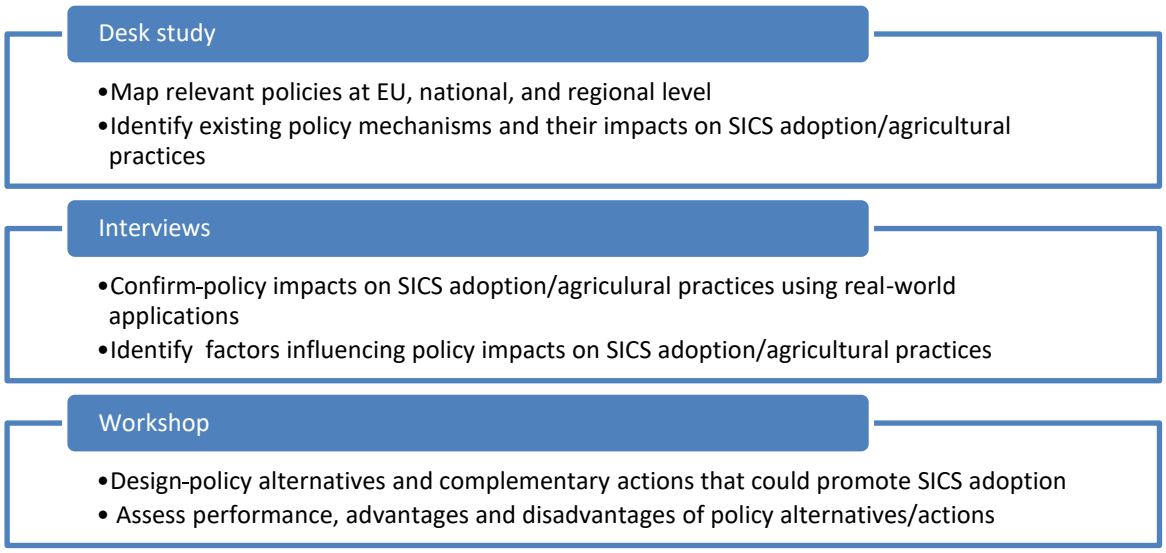


Figure 1: Research strategy and steps

2.2.1 Desk study

To identify the most relevant policies for shaping agricultural practices in general, and promoting SICS in particular, European strategies, policies and instruments were screened to identify those that relate to soil protection, including regulatory, planning, economic, and information instruments. **Error! Reference source not found.** sets out a brief overview of each type of information.

Table 3: Policy types

Policy category	Examples	Function
Regulatory instruments	European legislative acts, targets/standards, bans, permits/quotas, planning/zoning	Force actions to be changed
Planning instruments	Action programmes, strategies, communications	Orienting policymaking
Economic instruments	Tariffs, taxes, and subsidies	Discourage or reward behaviour through market mechanisms
Information instruments	Information campaigns, labelling, stakeholder and public participation, training, advisory services	Stimulating changes in public preferences and behaviour

The initial policy selection was limited to strategies, policies, and instruments with at least an

indirect link to soil within the main text of the EU strategy, policy, or instrument[21]. Based on this initial screening, the project team selected the most relevant EU, national, and regional policies. This selection was subsequently verified through interviews.

The mapping at EU-level identified a number of policies which are potentially relevant for the adoption of SICS. These policies are set out in **Error! Reference source not found.** below, split into overarching strategies that drive policy from a very high level, sectoral strategies, which concern more specific policy areas, and sectoral legislation, which regulate specific activities.

The initial policy analysis was concluded in February 2018. Since then, some of these policies and regulations were amended while the study was in progress and new initiatives, such as the Green Deal, were introduced. An in-depth analysis of these policies changes and initiatives was not carried out, however, they have briefly been considered with regard to the opportunities they provide when promoting the adoption of SICS.

Table 4: EU policies analysed in this study

EU policy	Reference	Policy area	Policy category
Overarching Strategies			
7th Environmental Action Programme to 2020 'Living well, within the limits of our planet' (7th EPA)	Decision No 1386/2013/EU	Environment	Planning
8th Environmental Action Programme to 2030 (proposal) (8th EPA)	COM(2020) 652 final	Environment	Planning
A Clean Planet for all: A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy	COM(2018) 773 final	Climate	Planning
The European Green Deal	COM(2019) 640 final	Horizontal	Planning
United Nationals Sustainable Development Goals (SDGs), set out in 2030 Agenda for Sustainable Development	-	Horizontal	Planning
Sectoral Strategies			
A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system	COM(2020) 381. final	Agriculture / Waste	Planning
A new Circular Economy Action Plan for a cleaner and more competitive Europe	COM/2020/98 final	Horizontal	Planning
A new EU Forest Strategy: for forests and the forest-based sector	COM(2013) 659 final	Biodiversity	Planning
EU Biodiversity Strategy for 2030 Bringing nature back into our lives.	COM(2020) 380 final	Biodiversity	Planning
Roadmap to a Resource Efficient Europe	COM(2011)0571 final	Energy	Planning
Thematic Strategy for Soil Protection	COM(2006)231 final.	Environment	Planning
Sectoral legislation			
Bird Directives	2009/147/EC	Nature	Regulation

[21] The output of this step is set out in Deliverable 7.1 (Inventory of opportunities and bottlenecks in policy to facilitate the adoption of soil-improving techniques), available at https://www.soilcare-project.eu/downloads/public-documents/soilcare-reports/85-report-9-deliverable-7-1-inventory-of-opportunities-and-bottlenecks-in-policy-to-facilitate-the-adoption-of-soil-improving-techniques/file.

EU policy	Reference	Policy area	Policy category
Common Agricultural Policy (CAP) Direct payments and market measures (Pillar I) and Rural Development (Pillar II) [22]	1305/2013/EU 1306/2013/EU 1307/2013/EU (COM/2018/392) (COM/2018/393) (COM/2018/3942)	Agriculture	Economic
Drinking Water Directive	98/83/EC 2020/2184	Water	Regulation
Environmental Quality Standards (EQS)	2008/105/EC	Water	Regulation
Fertilising Products Regulation[23]	2003/2003/EC (2019/1009/EU)	Chemicals	Regulation
Floods Directive	2007/60/EC	Water	Regulation
Groundwater Directive	2006/118/EC	Water	Regulation
Habitat Directive	92/43/EEC	Nature	Regulation
Nitrates Directive	1991/676/EEC	Water	Regulation
Organic Regulation	834/2007/EC (2018/848/EU)	Agriculture	Regulation
Sewage Sludge Directive	86/278/EEC	Waste	Regulation
Sustainable Use of Pesticides Directive (SUPD)	2009/128/EC	Chemicals	Regulation
Water Framework Directive (WFD)	2000/60/EC	Water	Regulation

For each study site, a similar exercise was carried out - policies potentially impacting the adoption of SICS were identified and briefly described in study site-specific policy inventories. The inventories included those national, regional, and sub-regional policies stemming from relevant EU policies; however, only those policies with a direct impact on the study site were considered (i.e., policies in other regions and sub-regions were not considered).

These inventories provided a broad overview of soil-related national and regional policies from which the most relevant policies could be selected for in-depth analysis. This was done through desk research carried out by the study site researchers and later complemented through the interview data collected in the next step. The policy inventories are available together with the EU policy inventory as part of Deliverable 7.1[24].

2.2.2 Interviews

Twelve EU-level interviews were carried out in collaboration with Work Package 6[25] to complement the desk research. The aim of the EU-level interviews was to gain a deeper understanding of the impact of various EU-level policies on agricultural practices which complemented the desk-based analysis of EU-level policies. The interviews aimed to elicit

[22] In June 2018, the proposal for the post-2020 CAP was tabled; the analysis presented in this document covers both the existing and proposed regulations (as they were published in June 2018).
[23] A new Fertiliser Regulation (2019/1009/EU) was adopted in May 2019 and will enter into force after a three year transition period.
[24] The policy inventories can be accessed at: https://zenodo.org/record/2613625
[25] WP6 (integrated assessment modelling and scenarios). For more detail see https://www.soilcare-project.eu/project-information2/work-packages2

information on the mechanisms through which agricultural and other policies impact on the practices farmers adopt, that is, how they work and why. This included questions on the shortcomings of the policies in terms of farmer adoption and gaps in the EU-level policy framework for encouraging soil conserving/improving agricultural practices as well as the interactions between the different policies, looking at trade-offs and synergies.

Interviewees consisted of EU-level policy experts and strategic thinkers. This included those involved in the policy-making process and strategic development such as officials from the EU institutions, as well as policy experts from NGOs, EU-level farmer associations, and other relevant interest groups. The aim was for the sample to match the scope of the policy analysis, i.e., to cover experts in the agricultural and other policy areas being analysed and involved those who have a broader perspective on the future of Europe to understand plausible future developments that might impact on the need, adoption or effectiveness of policies.

At the study sites, researchers conducted a total of 47 interviews with national and policy-makers and stakeholders. Interviews followed the same structure as the ones conducted at EU-level.

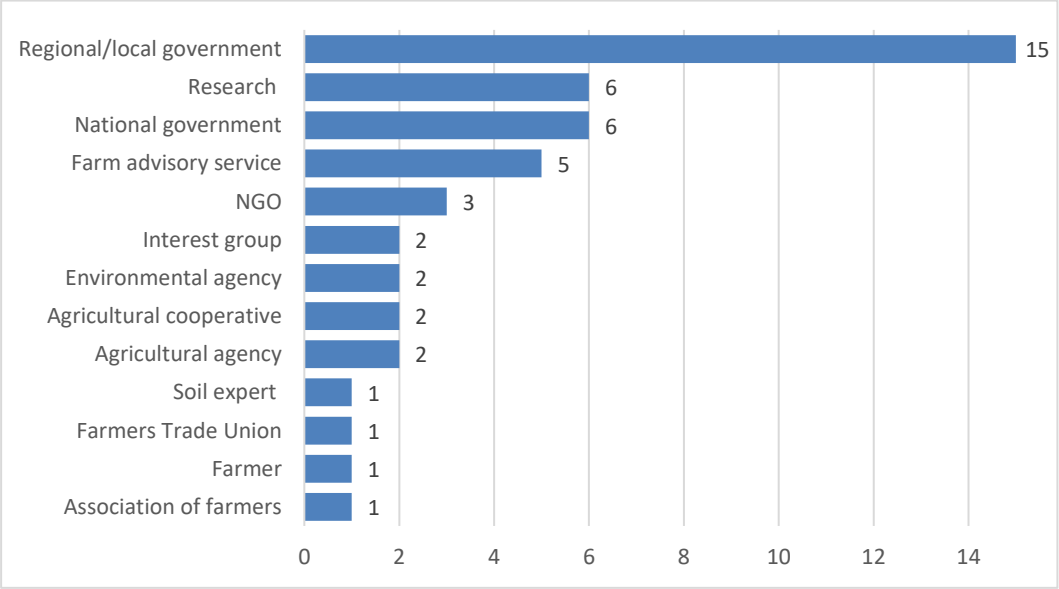


Figure 2: Study site interviews, by broad stakeholder category

2.2.3 Workshops

Both the desk study and the interviews provided first, general insights into the effectiveness of current policies in facilitating a more widespread uptake of SICS and recommendations for potential policy options.

EU-level stakeholder workshops

At EU level, we used scenarios to develop, assess and select policy alternatives. The activities were the following:

A first workshop was held in June 2019, which focused on the development of qualitative

exploratory scenarios that describe possible future states of Europe as a basis for testing the adoption of SICS and effectiveness of different types of policy instruments. 12 stakeholders attended the one-day workshop including Commission officials, researchers, representatives of farmers, landowners and industry as well as environmental NGOs.

Based on the interviews we conducted with EU-level stakeholders, we decided on a policy-relevant scenario framing along two axes: *future challenges for voluntary instruments* and *future challenges for mandatory instruments*. Using these axes, we created four quadrants which were used as the basis for the different scenarios (Figure 3).

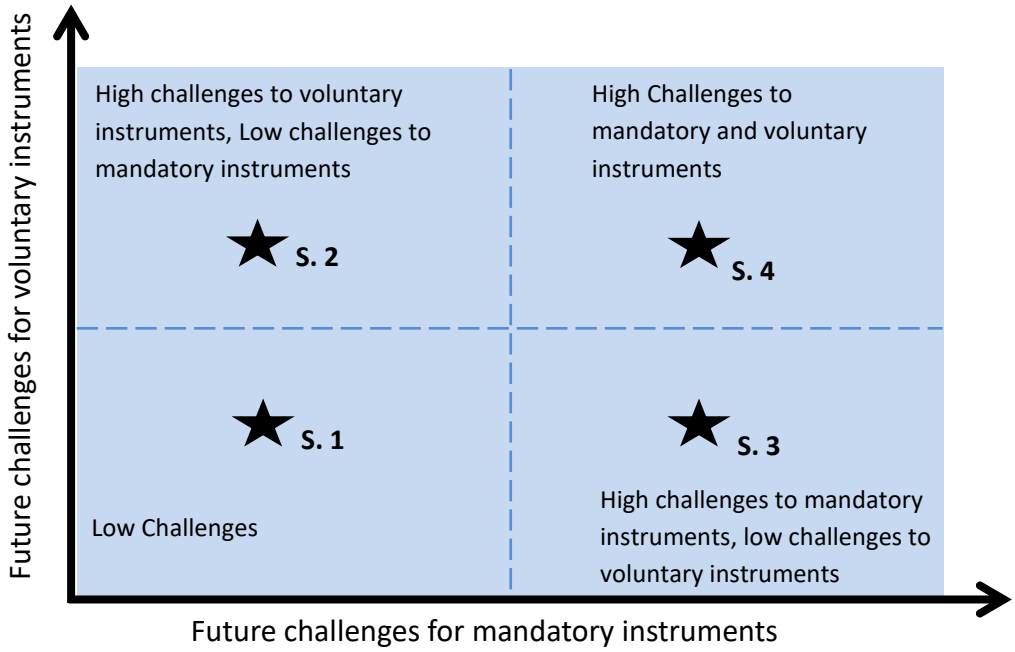


Figure 3: Scenario framing

Using this framework, participants provided input into the factors that would enable or challenge the adoption of measures and identified potential pathways for each scenario. In the follow-up, the research team drafted brief narratives for each scenario as a basis for the Integrated Assessment Model.

A follow up meeting was held online in April 2020. During this second meeting, structured as a webinar, the research team presented the narrative scenarios they developed based on the input provided by the participants during the 1st workshop. Participants to the webinar were then invited to provide comments on each scenario, exploring their different aspects. The aim of this exercise was to improve the scenarios by gathering further input, to ensure they provide a useful, relevant and well adapted background for the development of quantification models which is the next step in the study. 69 participants attended the webinar with similar profiles to the first workshops, including some participants who attended both events.

The 2nd Scenario Workshop was held online in May 2021. This final workshop had two main

objectives: to present the preliminary results of the modelling exercise and to identify policy actions which can promote SICS under the four scenarios which were previously developed. Excluding the team members, 25 participants attended the meeting, with similar profiles to first two workshops, including policy makers, farmers, and scientists.

First, the participants were invited to think about the link between the SICS and the wider EU policy objectives relevant for soil health. Second, the scenarios were briefly presented along with the barriers to, and enablers of adoption of SICS which were identified during the study. The participants were then divided into smaller groups and asked to suggest policy actions to overcome the barriers or reinforce the enablers under each scenario. They were also asked to vote on the actions proposed, in order to determine the most relevant ones. In the second part of the day, 11 actions which received the most votes were voted again, to determine how likely they would succeed under each scenario (see Annex III for the snapshot of the voting exercise). The objective of this exercise was to determine which policy actions would be relevant under a diverse set of conditions. The input from the participants were incorporated in the final set of recommendations, presented in Section 5.

Figure 4: Activities carried out as part of the scenario processes at EU level

Stakeholder workshops at the study sites

The Study Site Research Teams organised stakeholder workshops at each site to develop and assess policy alternatives, following a common guidance document which detailed the structure and methods for the event. Study Site Teams organised workshops in 13 of the 16

study sites[26].

Workshops amalgamated various perspectives and interests including those of farmers, policymakers, advisory services, and scientists. Study site teams mostly invited those stakeholders they were already working with, either within the context of SoilCare or as part of their regular engagement activities. Participant numbers ranged from five to 27 and represented a number of different stakeholder groups (see Figure 5).

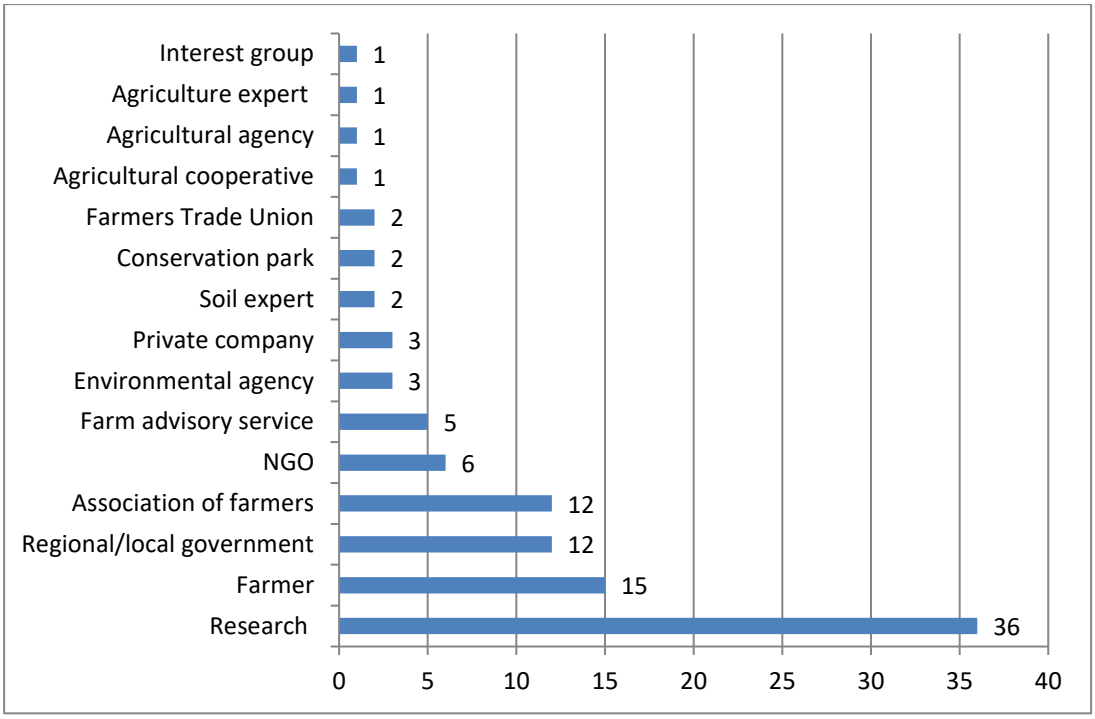


Figure 5: Number of participants of study site workshops by broad stakeholder category

The study site workshops were organised in three steps: (1) Description of the SICS being tested in the respective study site, and the expected benefits/impacts, (2) Identification of the main barriers and enablers to SICS adoption, and (3) Identification and assessment feasibility of actions to promote SICS adoption. Each step was carried out using interactive methods such as ranking exercises, small group work and plenary discussions[27].

3 Soil-Improving Cropping Systems: policy opportunities and shortcomings

Soil is a valuable resource and is clearly on the EU and international policy agendas. However, since the withdrawal of the proposal for the Soil Framework Directive, EU soil policy remains fragmented with no framework legislation dedicated to soil. The protection, maintenance, and improvement of soil therefore rely on several strategic, sectoral, and environmental policies that address different aspects of soil management, and softer policy initiatives and non-binding

[26] Belgium, Czechia, Switzerland, Germany, Spain, France, Greece, Italy, Norway, Poland, Portugal, Sweden, and the UK. In some sites, researchers coupled the workshops with individual farm visits where they discussed the same questions addressed during the workshops.

[27] See the workshop guidance annexed to this report for a detailed overview of the method proposed to the Study Site Teams.

targets. In return, improving soil health directly or indirectly contributes to a vast array of EU policy ambitions ranging from overarching strategic objectives to targets set out by specific policies.

This section explores the extent to which existing policy instruments regulate, incentivise, or promote SICS. The analysis then takes the converse approach to assess how SICS might contribute to realising both strategic and specific European policy objectives.

3.1 Overview of EU environmental policy levels

EU Environmental policy is built on an overarching the goal of living sustainably, taking into consideration environmental, social, and economic aspects, ensuring the planet is protected for future generations. This message is embodied in various overarching strategies in place stemming from EU and international initiatives. The most relevant of these include the UN Sustainable Development Goals, which focus on all aspects of sustainability, the EU Long-term Strategy, the 7th Environmental Action Programme, and the new Green Deal. Each of these overarching strategies sets out goals and ambitions, while taking a holistic approach to sustainability.

Under these overarching strategies, a number of sectoral strategies are proposed and implemented, which are usually focused on one specific component of sustainability – for the purpose of soil, these are strategies focused on biodiversity, circular economy, resource efficiency, and food production (Table 4). These sectoral strategies are generally much more specific than the overarching strategies, setting out the same goals and ambitions, but generally setting specific targets and actions through which these can be achieved.

These sectoral strategies are implemented by mechanisms which are designed to change the situation on the ground. At EU level this is usually done through legislation regulating actions hindering the achievement of the sectoral or overarching goals and ambitions, or other specific initiatives such as the Common Agricultural Policy, which offers an economic incentive to change behaviour. While some legislation predates overarching and sectoral strategies, the legislation may well be adapted or even removed under such strategies and new legislation, or policies may be added. The different types of policies are visualised in Figure 6 below.

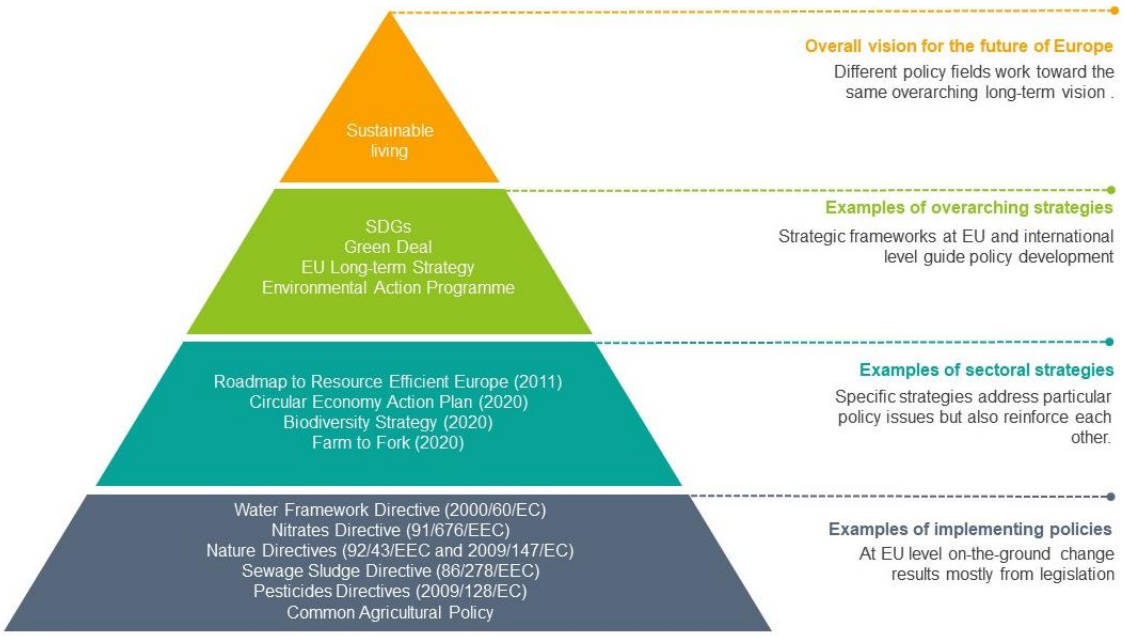


Figure 6: Levels of EU policy relevant for soil

The extent to which SICS play a role within these policies depends, for the most part, on the policy level of the initiative – overarching strategies often refer to soil and soil health, whereas towards the bottom of the triangle specific SICS or groups of SICS may become more apparent.

3.2 Existing EU policies that regulate, incentivise, and promote the adoption of SICS

It is clear that soil and soil health are visible in existing environmental policy, however, when considering how the existing framework impacts SICS adoption, it makes sense to start at the bottom – the implementing policies. It is at this level that individual SICS can be associated to existing policies that regulate, incentivise, or promote SICS to varying degrees.

This section provides an overview of how different relevant implementing policies interact with SICS and their uptake.

Agricultural policies

Policies dealing with agriculture and its impacts are directly relevant for SICS, as they have implications for farmers' choices regarding the entire process of agricultural production.

Common Agricultural Policy

The Common Agricultural Policy (CAP) is one of the earliest policy frameworks of the European Union which aims to provide *affordable, safe and nutritious food* to European citizens[28], while achieving more sustainable production and contributing to environmental objectives.

[28] The European Commission, The common agricultural policy at a glance, accessed 01.07.2018.

Furthermore, it supports competitiveness of the European farming industry[29]. Payments are tied to farmers meeting Statutory Mandatory Requirements (SMR), Good Agricultural and Environmental Conditions (GAEC), and the greening requirements set out by the policy. Greening requirements include: crop diversification, permanent grassland, and Ecological Focus Areas (EFA). Farmers with over 15 ha of arable land have had to devote 5% of their farmed area to EFAs to qualify for full direct subsidy payments. In addition to these conditional payments, the Rural Development Programmes (RDP) provides funding for contractual, voluntary commitments by farmers to implement certain sustainable agricultural practices.

These mechanisms fall under two pillars directly impacting farmer practices: greening measures and cross-compliance (Pillar 1) and Rural Development Policy (Pillar 2).

Starting with **Pillar 1,** under the current legislation[30] certain instruments have explicit links to maintaining or improving soil quality. Following the greening measures or payments, Member States must reserve 30% of their national ceilings for direct payments to grant an annual payment, in addition to the basic payment for compulsory practices to be followed by farmers addressing, as a priority, both climate and environment policy goals. The requirements under greening measures specifically target biodiversity, however, they are also explicitly linked to soil quality.

All groups of SICS are potentially targeted by CAP Pillar 1 depending on the specific instrument (e.g., greening, or cross-compliance), but the biggest potential impact can be seen for **cover crops** and **catch crops, crop rotations,** and to a lesser extent on **integrated pest management, controlled drainage** and **integrated landscape management.**

Cover crops and catch crops may be selected at national level as possible measures under EFAs (greening) and target buffer strips, green cover, restrictions on conversion of permanent grassland to arable crops, and re-conversion to grassland. Cover crops are also addressed by cross-compliance as certain GAECs contain cover crop requirements (e.g., concerning the duration or location of use). Holdings over ten hectares must have more than one crop, so farmers are encouraged to reduce intensive mono-culture practices and increase crop diversity and rotation. However, this only partially addresses **crop rotations**. The measure regarding permanent pasture can potentially limit long crop rotations by limiting the possibility to plough up pasture that has been established for > 5 years.

Controlled drainage is potentially targeted under the GAEC 3 (Protection of ground water against pollution) and under the new CAP by GAEC 2, appropriate protection of wetland and peatland. **Integrated pest management** is not directly targeted although several EFA

[29] The European Commission, The future of common agricultural policy, accessed 01.07.2018.
[30] The future of the CAP is currently being negotiated between the EC, Parliament and the European Council. The current deadline for concluding the negotiations is 2022.

measures could also include integrated pest management strategies. **Integrated landscape management** is potentially covered under GAEC 7 (retention of landscape features) and under GAEC 10 (Ban on converting or ploughing permanent grassland in Natura 2000 site) under the new CAP.

Integrated nutrient management is potentially targeted by cross-compliance with the Statutory Management Requirements (SMR) on Nitrates Directives directly impacts on farmers management of nutrients. There are no directly relevant standards under CAP for **reduced tillage**, but such practices would satisfy GAECs for improving soil organic matter and reducing soil erosion, therefore indirectly incentivising behaviour. Under the new CAP structure, reduced tillage is also potentially partially covered under GAEC 6 (tillage management reducing the risk of soil degradation, including slope consideration). **Smart residue management** is indirectly targeted since cross-compliance includes GAECs on improving soil organic matter and a ban on burning of stubble but does not include any requirements on residue management. **Error! Reference source not found.** below sets out the GAECs that impact soil, comparing the current and proposed legislation.

Table 5: GAECs that impact soil, current and the proposed system

Objective/Area of intervention	2014-2020	Proposed post-2020
Climate and environment	**GAEC 6:** Maintenance of soil organic matter level through appropriate practices including ban on burning arable stubble, except for plant health reasons	**GAEC 1:** Maintenance of permanent grassland based on a ratio of permanent grassland in relation to agricultural area **GAEC 2:** Appropriate protection of wetland and peatland **GAEC 3** Ban on burning arable stubble, except for plant health reasons
Water	**GAEC 1:** Establishment of buffer strips along water courses	**GAEC 4:** Establishment of buffer strips along water courses **GAEC 5:** Use of Farm Sustainability Tool for Nutrients
Soil	**GAEC 4:** Minimum soil cover **GAEC 5:** Minimum land management reflecting site specific conditions to limit erosion **GAEC 6:** same as above	**GAEC 6:** Tillage management reducing the risk of soil degradation, including slope consideration **GAEC 7:** No bare soil in most sensitive period(s) **GAEC 8:** Crop rotation
Biodiversity and landscape	**GAEC 7:** Retention of landscape features, including where appropriate, hedges, ponds, ditches, trees in line, in group or isolated, field margins and terraces, and including a ban on cutting hedges and trees during the bird breeding and rearing season and, as an option, measures for avoiding invasive plant species	**GAEC 9:** Minimum share of agricultural area devoted to non-productive features or areas Retention of landscape features Ban on cutting hedges and trees during the bird breeding and rearing season and as an option measures for avoiding invasive plant species **GAEC 10:** Ban on converting or ploughing permanent grassland in Natura 2000 sites

Under Pillar II, there are several Rural Development Programs aspects that could substantially impact the adoption of SICS. Two priorities and focus areas defined by the CAP specifically

address soil quality and several measures have been identified that could potentially address SICS components. RDP funding can potentially impact SICS adoption by reducing transaction costs of adopting practices that in the short term have higher associated costs.

Funding available under European Agricultural Rural Development Fund (EAFRD) can also be used for tangible and intangible investments for agri-environmental climate objectives, including of the types of SICS covered by the SOilCare project. More specifically, **green manures, cover crops, catch crops** can be incentivised as development measures can cover transaction costs associated with cover crops i.e., seeds and increased use of machinery, and targeted cover crops identified in SoilCare project could be included in an agri-environmental-climate payment. The same applies to **crop rotation**, as costs associated with crop rotation can potentially be covered by Agri-environment-climate Measures (AECM).

Integrated nutrient management is also targeted, since RDP measures can be used to finance manure storage and/or small-scale bio refineries to reduce Greenhouse Gas/Ammonia emissions. In the same vein, activities to provide information and awareness raising among the farmers about nutrient management and nutrient runoff/leaching can be financed under the same structure.

Enhanced efficiency irrigation, controlled drainage and reduced tillage can be incentivised since RDP measures intended for physical investments can be used for more efficient irrigation systems and/or drainage systems as well as for covering costs associated with specific machinery required for zero tillage or low tillage practices.

CAP in the post-2020 period[31]

In 2018, the European Commission published their proposal for transforming the CAP in the post-2020 period. Although the process is still ongoing, it is very likely that the outcome will significantly transform the current structure therefore also impact the adoption of SICS. Under Pillar I, the new proposal replaces cross-compliance and greening with enhanced conditionality to boost the environmental ambition of the CAP. This has a potentially positive impact on soil. Under the new structure, Member States will have more flexibility to define their national plans (to be approved by the Commission) and to set targets for the GAECs to which direct payments will be linked. Some of the new conditions incorporate greening requirements: permanent grassland (GAEC 1), EFA (ecological focus areas) (GAEC 9), and crop rotation is introduced to replace crop diversification (GAEC 8). Other new additions include the protection of wetlands and peatlands (GAEC 2). The proposal includes three GAECs specifically targeting soil, namely GAEC 6 (minimum land management under tillage), 7 (soil cover) and 8 (crop rotation). All of these changes have considerable potential to make a positive contribution to soil health, especially given that incorporating greening measures into GAECs means that they are applicable to all farms (instead of the 15ha limit under the current CAP).

Furthermore, the new CAP proposal introduces a system called eco-schemes under Pillar I. Eco-schemes

[31] The analysis is based on the proposal that was put forward by the European Commission in 2018 and does not take into account subsequent discussions. On June 28th 2021, relevant Ministers of the Member States had agreed on the provisional text but the details are still subject to change, during the process of interinstitutional negotiations. The text will only be final once it is formally approved by the European Parliament and the Council.

will be available to farmers based on a list of practices (established by the Member States) that are beneficial for the environment and climate. Member States must design these, although farmers may voluntarily adopt them. To avoid possible overlaps with other requirements, the proposal explicitly notes that these practices should go beyond relevant SMRs and GAECs. Eco-schemes are part of the national direct payment budget and will be paid annually to farmers as additional payments who go beyond the basic requirements. They are designed to be applied on an annual commitment basis to provide flexibility to farmers to continue or cease practices depending on their outcome. Depending on the way they are designed and implemented, eco-schemes can provide additional incentives for farmers to pursue activities that are good for the environment in general, and soil in particular.

The proposal also introduces changes to Pillar II: the budget for Pillar II will be reduced while the Member States may now to transfer funds between the two pillars. Currently, the AECMs are important for delivering environmental objectives and are the second most important measure in terms of financial allocation[32] As in the current system, practices financed under Agri-environment-climate measures must go beyond what the farmers are already doing to fulfil enhanced conditionality. These farmer commitments can span longer time periods, for five to seven years, or even longer where necessary to achieve or maintain environmental benefits. This can be considered a positive improvement for soil-related engagements which need longer time periods and encourage farmers to uptake certain practices as also identified by this study.

Organic Regulation

The Organic Regulation[33] and the associated implementing acts regulate the conditions for production and labelling of organic agricultural produce in the EU. Preservation of soil health is one of the objectives of the Organic Regulation along with other relevant objectives such as protection of biodiversity and responsible use of water and other natural resources.

SICS covering pesticide use and fertiliser input are the relevant when considering the Organic Regulation. **Integrated pest management** and **integrated nutrient management** are directly incentivised if farmers want to follow the rules of the regulation and sell their products as organic. Furthermore, the regulation requires multi-annual crop rotation and the use of livestock manure or organic matter help to preserve and increase soil fertility while combatting soil erosion, compaction, and organic matter decline. These incentivise **crop rotation, smart residue management**, and **controlled traffic management** either directly or indirectly. Since most of these components are facilitated through **integrated landscape management**, this SICS is also considered to be indirectly relevant.

Water policies

Agricultural management and practices impact on nutrients, water use, and pollution, all of which concern maintaining or enhancing soil quality. Except for the Nitrates Directive, EU water legislation does not explicitly address agricultural practices. However, water legislation does have a (mostly) indirect impact on cropping systems, through objectives, standards and

[32] See https://enrd.ec.europa.eu/

[33] EU regulation 834/2007 on organic production and labelling of organic products

instruments are primarily aimed at protecting, maintaining, and improving water quantity or water quality.

The **Nitrates Directive**[34] directly influences agricultural practices by requiring standards on management of nutrients and physical features such as buffer strips and storage of manure. **Green manures, cover crops, catch crops** and **crop rotations** are potentially encouraged as they are part of the voluntary codes of Good Agricultural Practice (GAP) required by Nitrates Directive, which include requirements for crop rotations, soil winter cover, and catch crops to prevent nitrate leaching and run-off during wet seasons. **Integrated nutrient management** is directly regulated as the Directive establishes maximum levels of nitrogen applied, periods and landscapes where application of nitrogen-based fertilisers is inappropriate and designates Nitrate Vulnerable Zones (NVZ) and GAPs relating to reducing nitrogen runoff such as cover, catch crops, and buffer strips.

Enhanced efficiency irrigation is not directly targeted as there are no directly relevant standards, but the standards have an indirect impact as they aim at ensuring sufficient quality and quantity of water. In the same vein, although there are no directly relevant standards for **reduced tillage**, the technique reduces need for application of nitrogen-based fertilisers and could be used as strategy for reduction of nitrogen leaching especially in designated NZVs.

The **Water Framework Directive**[35] explicitly uses economic tools to ensure users pay the real costs of the water they use. This is expected to provide incentives to stop users (i.e., farmers) from excessive water consumption. This indirectly incentivises practices such as **enhanced efficiency irrigation.** Furthermore, the WFD aims to reduce and prevent pollution of waters from, among others, pesticides, and nutrients, thus it at least indirectly promotes practices such as **enhanced efficiency irrigation, controlled drainage, integrated pest and nutrient management**.

In addition, both the WFD and the Nitrates Directives set out voluntary measures (at either Member State or farmer level respectively). These measures may also influence a farmer's decision with regard to **nutrient management, efficient irrigation, crop rotation** and decisions on **crop types.**

Directives that set out specific chemical standards (the **Groundwater**[36] and **EQS Directives**[37] in particular) may greatly impact cropping practices by placing restrictions on what chemicals can be used for pest control or fertiliser. As such, they directly promote **integrated pest management.**

[34] Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources
[35] Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy
[36] Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration
[37] Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy

The **Floods Directive**[38] establishes a framework for the assessment and management of flood risks, aiming to reduce the adverse environmental impacts. The Directive does not explicitly refer to soil protection in the objectives or measures, however, the integrated flood management approach set out by the Floods Directive may indirectly promote practices that aim to maximise natural infiltration and retention capacities of soils. Farmers might thus be encouraged to implement practices such as **integrated landscape management**, **controlled traffic management**, **green manures, cover crops, catch crops.**

Nature policies

The **Birds**[39] and **Habitats**[40] **Directives** (collectively known as the Nature Directives) comprise the main policies protecting, conserving, and improving biodiversity. Instruments under these measures impact farmers generally at landscape level, but in some cases on farmer's specific management practices such as cropping patterns, timing of tillage and crop rotation in relation to preserving wildlife.

More specifically, the Nature Directives encourage **integrated nutrient management** and **reduced tillage**. Furthermore, species listed in the Annex II of the Habitat Directives may require more stringent action, especially regarding nutrient levels. In a more general manner, reduced tillage systems can benefit farmland bird population and habitats.

Waste policies

The **Sewage Sludge Directive**[41] (SSD) promotes the use of sewage sludge in agricultural areas by providing a legal framework to mitigate potential risks, in particular due to the accumulation of heavy metals in soil. The use of sewage sludge in agriculture could also close nutrient loops in line with the circular economy strategy. The SSD influences agricultural practices primarily through fertilisation and nutrient management.

The SSD sets limits for land-based applications and establishes maximum levels of pollutants in sewage sludge (although most Member States have stricter standards compared to SSD), thus **integrated nutrient management** practices are indirectly incentivised since sewage sludge is a cost-efficient nutrient source.

Chemicals policies

The **Sustainable Use of Pesticides Directive**[42] is designed to achieve more sustainable use of pesticides by requiring Member States to develop clear, measurable targets to reduce risks from pesticides set out in National Action Plans (NAPs) to reduce pesticide use. The SUPD

[38] Directive 2007/60/EC on the assessment and management of flood risks
[39] Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds
[40] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora
[41] Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture
[42] Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides

affects farmer's decisions and practices relating to pest management and weed control, and provisions relating to Integrated Pest Management (IPM, set out in Annex III of the Directive) are perhaps the most significant for promoting agricultural practices to improve soil quality and synergies exist, for example through crop rotation and pest management.

Cover crops, catch crops and crop rotations may be included under measures relating to integrated pest management in NAPs. The same applies for **enhanced efficiency irrigation** (through use of balanced fertilisation, liming and irrigation/drainage) and **reduced tillage** (through conservation agriculture) as they are included in the list of practices for IPM in the Annex III of the SUPD.

The **Fertilisers Regulation**[43] covers the commercial fertiliser market however, it indirectly impacts farmers and their practices as it limits the range of fertilisers accessible. The amended Regulation expanded the scope of fertilisers which can be labelled CE, covering organic, inorganic, soil amendments and growing mediums. It also provides clear criteria for the maximum levels of certain contaminants in different types of fertilisers. By providing a harmonised legal framework, it encourages the use of recycled and organic materials as fertilisers. This addresses issues related to the supply of and demand for organic fertilisers. Furthermore, although the Regulation does not have measures or targets which specifically target soil, it indirectly addresses threats from acidification, diffuse contamination, and loss of soil organic matter. The group of SICS that is most likely incentivised by the regulation is **integrated nutrient management,** since it makes organic fertilisers more accessible for the farmers. Furthermore, the regulation might have an impact on different uses of residues by opening up the possibility to commercialise recycled and organic material as nutrients.

The table below summarises the potential contribution (either direct or indirect) of policies to the adoption of SICS. The table also highlights shortcomings in existing policy where certain groups of SICS are not sufficiently supported, leading to possible recommendation for future improvement. For example, crop rotation, integrated nutrient management, green manures, cover crops, catch crops and to a lesser extent, controlled drainage and integrated pest management are covered to a higher extent than other SICS. It is also noted that some policies such as Organic Regulation provides coverage for a larger number of SICS, pointing to a more holistic approach to soil and environmental management. On the other hand, more specific legislation such as those covering fertilisers and pesticides provide more targeted incentives for a limited number of SICS.

[43] Regulation (EU) 2019/1009 of the European Parliament and of the Council of 5 June 2019 laying down rules on the making available on the market of EU fertilising products and amending Regulations (EC) No 1069/2009 and (EC) No 1107/2009 and repealing Regulation (EC) No 2003/2003

Table 6: Existing legislation and the potential contribution to adoption of groups of SICS

EU policy / SICS group	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management (fertilisation soil amendments)	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management (compact alleviation)	Integrated landscape management
Agricultural policies											
CAP Pillar 1	+	++			+		+				+
CAP Pillar 2	+	+	+	+	+	+					
Organic Regulation	++		++		++		++		+	+	+
Water policies											
WFD	+	+	++	+	++		+				
Nitrates Directive	+	+	++	+		+					
Groundwater Directive							+				
Floods Directive		+								+	++
EQS Directive							+				
Nature policies											
Nature Directives			+			+					
Waste policies											
SSD			+								
Chemicals policies											
SUPD	++	++		+		+	++	++			
Fertilisers Regulation			++						+		

Key: *"++" Direct contribution to objectives*
"+" Indirect contribution to the objectives
[blank] Not relevant/ negligible contribution

Existing national policy

In parallel to an analysis of the potential contribution of EU-level policies to the adoption of SICS, a detailed analysis was carried out to determine to what extent national and regional instruments in the study site countries already regulate, incentivise, and promote (through voluntary instruments), the adoption of SICS (see Annex II).

Figure 7 below summarises the findings of the analysis. It can be seen that not all groups of SICS are promoted equally by Member State policies: a high number of policy instruments concern integrated nutrient management, while comparatively fewer policies cover controlled traffic management and smart weed control. It can be assumed that the choices of the Member States are impacted by their local context and needs.

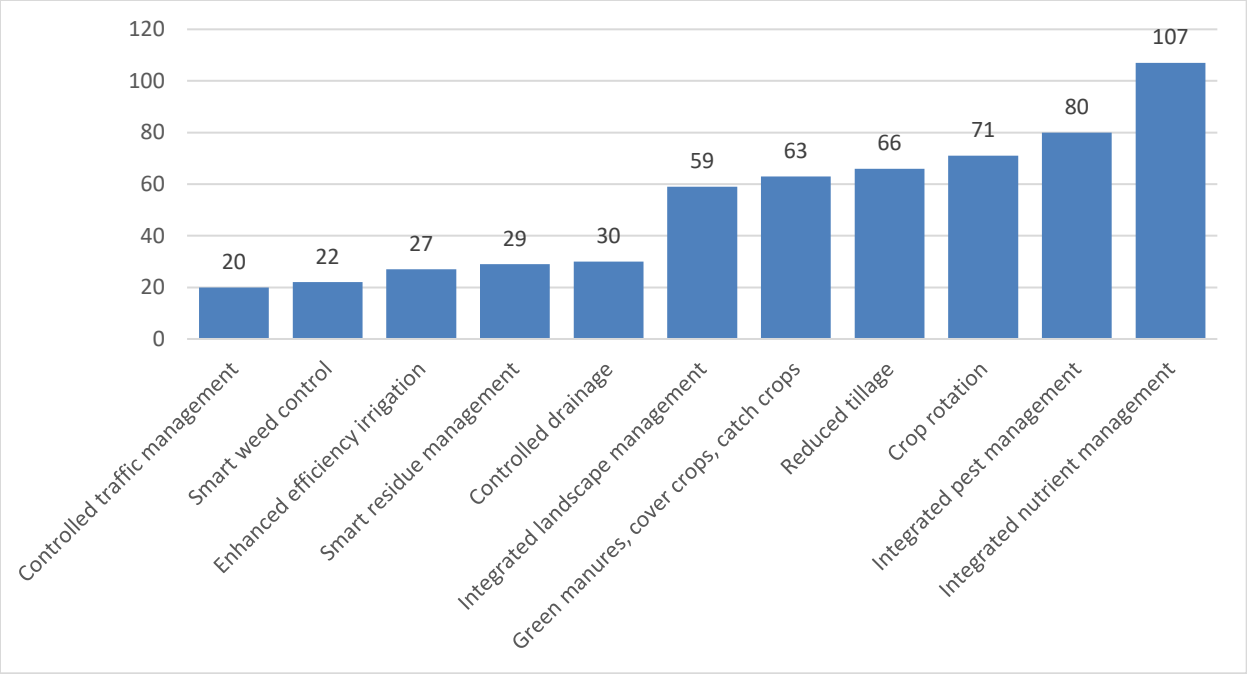


Figure 7: Number of measures targeting groups of SICS in the 16 Member States.

3.3 SICS contribution to EU policy objectives and targets

Although it is clear that the existing EU policy framework promotes the adoption of SICS, SICS also play a role when it comes to achieving the objectives of the policies discussed above, including, among others, sectoral legislation such as the Water Framework Directive, Nature Directives and Pesticides Directive. Table 7 below summarises how SICS can contribute to policies

designed to change behaviour by focusing on the sectoral policies discussed in the previous section.[44]

[44] See detailed analysis in SoilCare Deliverables D7.1 Inventory of opportunities and bottlenecks in policy to facilitate the adoption of soil-improving techniques, available at https://www.soilcare-project.eu/downloads/soilcare-reports-and-deliverables/85-report-9-deliverable-7-1-inventory-of-opportunities-and-bottlenecks-in-policy-to-facilitate-the-adoption-of-soil-improving-techniques

Table 7: Contribution of SICS to objectives put forward by EU sectoral legislation. Source: …

EU policy / SICS component	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management (fertilisation soil amendments)	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management (compact alleviation)	Integrated landscape management
Agricultural policies											
CAP Pillar 1	+	+	+	+		+				+	+
CAP Pillar 2	+	+	+	+		+					
Organic Regulation			++				++				
Water policies											
WFD (and daughter directives)	+	+	+	+		+				+	
Nitrates Directive	+	+	++	+	+						+
Nature policies											
Nature Directives	+	+				+				+	+
Waste policies											
SSD			+								
Chemicals policies											
Pesticides Directive	+						++				
Fertilisers Regulation	+		++								

Key: *"++" Direct contribution to objectives*
"+" Indirect contribution to the objectives
[blank] Not relevant/ negligible contribution

The legislation and policies discussed so far do not exist in a vacuum – they fall under sectoral strategies, setting out more general targets, which may in turn be linked to SICS. The links between the SICS and sector-specific strategies are more visible, although it is not always possible to clearly distinguish types of SICS in terms of their specific contribution to each of these strategies. Sectoral strategies such as EU Forest Action Plan and Forest Strategy, Farm to Fork, Biodiversity Strategy or Circular Economy Action Plan have specific ambitions related to soil and its functions, which makes the SICS directly beneficial.

Considering an even higher policy level, all SICS potentially contribute to a more sustainable, resource efficient Europe while ensuring the well-being of European citizens, thus contributing to the overarching EU environmental strategies. Table 8 below sets out the most relevant soil targets in these strategies, and it is clear the targets are broad: protect soils, reduce contamination, and restore degraded areas. It is noted that the targets in the different strategies are clearly similar, which reflect the fact that healthy soils fit into the overall vision of sustainable living.

Error! Reference source not found. lists the overarching strategies and the sectoral policies relevant for soil and presumably SICS. It also sets outs out the targets relevant for soil.

Table 8: Soil targets in EU overarching and sectoral strategies

Policy	Targets relevant for soil
Overarching Strategies	
7th Environmental Action Programme to 2020 'Living well, within the limits of our planet' (7th EPA)	• Reduce soil erosion • Increase soil organic matter
8th Environmental Action Programme to 2030 (proposal) (8th EPA)	• Achieve zero pollution and a toxic free environment, including soils • Protect and restore ecosystems, including soils
A Clean Planet for all: A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy	• Increase the capacity of soils to contribute to the climate policies, such as carbon removal and carbon sinks • Reduce CO_2 emissions from the agricultural sector through sustainable and efficient production
The European Green Deal	• Achieve zero pollution of soils
United Nationals Sustainable Development Goals (SDGs), set out in 2030 Agenda for Sustainable Development	• Promote sustainable food production and resilient agricultural practices • improve land and soil quality • Better environmental management of chemicals and waste to reduce their release to air, water and soil • Fight desertification and restoring degraded land and soil, strive to achieve a land degradation-neutral world
Sectoral Strategies	
A Farm to Fork Strategy for a fair, healthy and environmentally friendly food system	• Promote the objective of zero pollution from nitrogen and phosphorus flows from fertilisers by at least 50% and fertiliser use by at least 20% by 2022 • Reduce the overall use of and risk of chemical pesticides by 50% and the use of more hazardous pesticides by 50% by 2030 • Achieve at least 25% of the EU's agricultural land must be organically farmed by 2030; • Promote use of alternative agricultural control practices and techniques, such as crop rotation and mechanical weed control • Facilitate placing on the market of plant protection products containing biological active substances

Policy	Targets relevant for soil
	• Develope a sustainable food production system by encouraging agricultural practices that allow for high carbon sequestration
A new Circular Economy Action Plan for a cleaner and more competitive Europe	• Improve water reuse and efficiency in agriculture
	•
EU Biodiversity Strategy for 2030 Bringing nature back into our lives	• Protect at least 30% of Europe's land area and strict protection of at least 1/3 of these areas. • Reduce nutrient losses by at least 50% and fertiliser use by at least 20% • Reduce the use of chemical pesticides and high-risk pesticides by 50%, • Recognise at least 10% of agricultural land as high-diversity landscape features • Ensure at least 25% of the agricultural land is cultivated with organic farming
Roadmap to a Resource Efficient Europe	By 2050, all resources are sustainably managed, including land and soil: • By 2020, the area of land in the EU that is subject to soil erosion of more than 10 tonnes per hectare per year should be reduced by at least 25 %, and • By 2020, SOM levels do not decrease overall and increase for soils currently with less than 3.5 % organic matter.
Thematic Strategy for Soil Protection	• Prevent further degradation of soil, preserve its functions and restore degraded soil

Taking both the overarching and the sectoral strategies together, the targets can be grouped into eight general targets, set out in **Error! Reference source not found.**9 below. From there it is possible to compare the contribution of the SICS to the achievements of the strategies.

Table 9: Intended contribution of groups of SICS to objectives put forward by different EU strategies and action plans.

EU soil targets / SICS components	Crop rotation	Green manure, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
Reduce soil erosion and desertification	+	++		++		+				+	+
Protect and restore soil health	++	+	++			++				++	
Limit and halt pollution from pesticides	+						++				
Limit and halt pollution from nutrients	+	+	++	+	+						
Promote organic and sustainable farming											+
Ensure agriculture contributes to climate mitigation/adaptation						+				+	
Improve resource efficiency in agriculture		+		++	++				+		
Ensure agriculture contributes to protecting/restoring biodiversity		+				+	++				++

Key: *"++" Direct contribution to objectives*
"+" Indirect contribution to the objectives
[blank] Not relevant/ negligible contribution

4 Factors influencing the adoption of Soil-Improving Cropping Systems

The analysis presented in Section 3 concluded that multiple policies already exist, at EU, national and regional level, which directly or indirectly facilitate a wider uptake of SICS, and the protection of soil in general. Yet, the transition to sustainable agricultural practices is slow, raising the question of the effectiveness and impacts of these instruments in fostering the desired change. We presented an analysis of shortcomings and opportunities of the existing EU level policy framework in a previous report[45]. Findings can be summarised as follows:

- Stakeholders expressed concerns that the system of payments under the CAP may potentially encourage farmers to engage in practices that are environmentally harmful in order to obtain or maximise their payments. They highlighted that CAP instruments may actually support current industrial farming practices rather than promote a transition to more sustainable agricultural systems, and that the established system of payments may create a sense of entitlement that creates resentment when rules for payments are changed.
- Although relevant literature shows that the objectives of EU water policy are integrated into agricultural policy at the strategic level, the impact of this integration depends on the effective implementation of the agricultural policies at Member State level.
- Assessments of the Nature Directives show that outside Natura 2000 habitat sites, obligations imposed on farmers to protect threatened habitats and species of Community importance were often poorly defined, and legislation was not enforced. It seems that even within Natura 2000 sites, management plans drawn up for each site have little impact on farmers' decisions.
- Member States have largely implemented stricter limits than those recommended by the Sewage Sludge Directive, but there is substantial variation between Member States, with several Member States using practically no sewage sludge in agriculture, preferring to incinerate it.
- Recent reviews of the SUPD show that on the one hand, Member States have provided a high level of training and certification for professional users, distributors, and advisors, carried out comprehensive information and awareness activities, implemented a range of measures to protect the aquatic environment from pesticide use and to reduce pesticide use in specific areas; and severely restricted aerial spraying, with strict conditions on its use. On the other hand, the overall rate of compliance and an assessment of tangible results is missing in the absence of measurable targets in most national action plans.
- Evidence shows that many fertilisers sold under national legislation comply with the technical standards specified in the Fertilisers Regulation. However, there is no evidence

[45] D7.1 Inventory of opportunities and bottlenecks in policy to facilitate the adoption of soil-improving techniques, available at: https://www.soilcare-project.eu/resources/deliverables

supporting the argument that the Regulation has led to improvements regarding fertilisers' impacts on the environment, particularly regarding the presence of heavy metals in fertilisers, which may leach into soils.

Against this background, our investigation focused on understanding common barriers to the adoption of soil improving practices as a basis for identifying and designing policy measures to encourage farmers to adopt effective soil conservation practices.

Facilitators of and barriers for adoption can be grouped into the following broad categories: economic, biophysical, technical, knowledge and information, socio-cultural, institutional and policy, as set out in Table Table 10[46].

Table 10: Enablers and barriers for SICS adoption by farmers

Category of enabler/barrier	Description
Economic (farm/market)	Market conditions might be favourable or not. Market conditions might include prices, supply chain arrangements and possible food assurance schemes/protocols, the role of private sector actors, consumer preferences and consumption patterns. New practices might not seem profitable or come with high investment and labour costs.
Biophysical	Climate and soils might be favourable or unfavourable.
Technical	Techniques/practices might not be sufficiently tested yet or required acquisition of new skills/training.
Knowledge / information	Farmers may not be sufficiently informed about soil improving practices/cropping systems or the extent to which the technique/practice might be applicable to them.
Socio-cultural factors	Farmers are unwilling of testing new practices and techniques; limited promotion of SICS by farmer organisations.
Institutional/policy	Policies (including regulation, economic, voluntary and information instruments) hinder the uptake of SICS by subsidising or promoting other practices.

The following sections present more detailed analysis of the most significant factors affecting the successful SICS implementation based on information provided from the stakeholders we consulted at the European level and in the study sites.

4.1 Factors affecting SICS adoption in general

Both EU and national level stakeholders were asked to identify the most prevalent factors in relation to agricultural practices and SICS adoption in general**.** The results are presented in the charts below and described further in the text.

While the EU stakeholders consider **socio-cultural factors** as the ones most significant for SICS adoption, followed by **policy factors**, while **policy/institutional factors** are by far the most influential factors shaping agricultural practices at the study site level, followed by

[46] The categorisation is adapted from Lahmar R. (2010), *Adoption of conservation agriculture in Europe. Lessons of the KASSA project*, Land Use Policy 27 (2010) 4–10, and Delden V H., et al, (2019), RECARE Project Deliverable D8.4, *Barriers and opportunities of adoption at European scale.*

economic factors. Furthermore, study-site level stakeholders consider **knowledge and information** as the third most significant factor for SICS adoption, whereas at EU level, this factor has less relevance. In contrast, a significantly higher number of EU stakeholders than stakeholders surveyed in the study sites identified socio-cultural factors as key factors for adoption. Biophysical factors bear approximately the same importance for both the EU and study site level stakeholders.

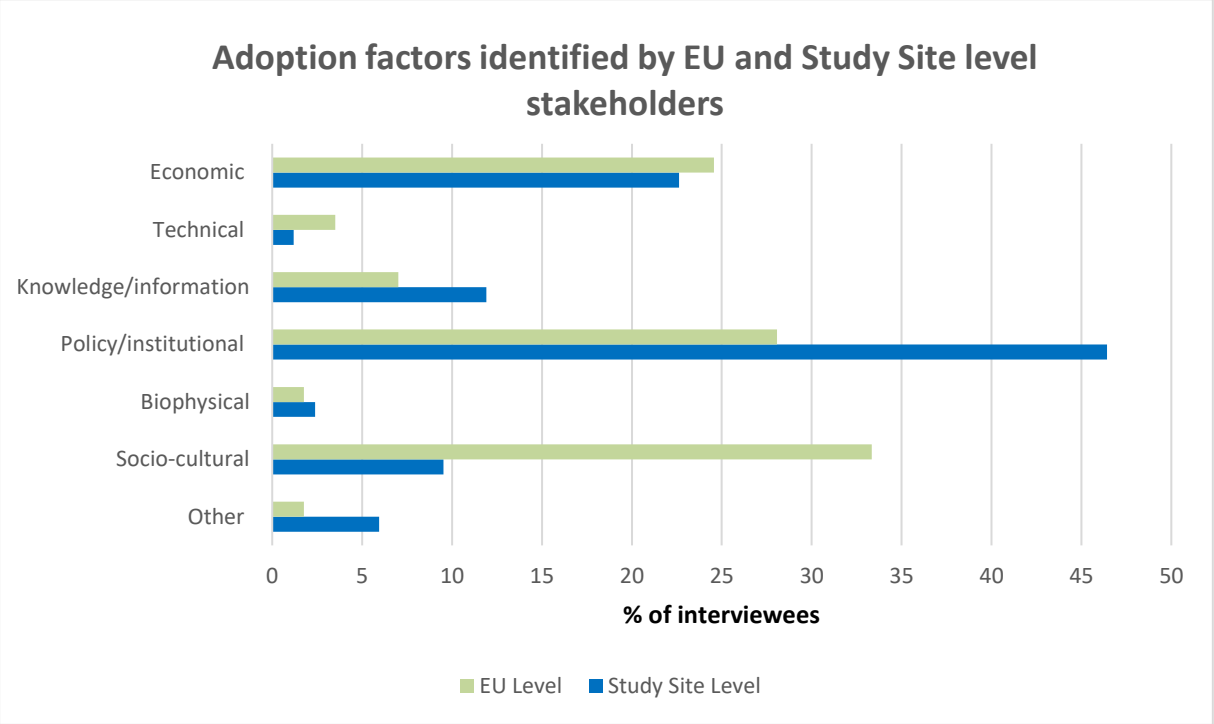


Figure 8: Factors affecting SICS adoption, as identified by interviewed EU and study site stakeholders.

The most frequently mentioned adoption factors as identified in each study site during the stakeholder interviews[47], were policy/institutional factors. These were brought up most frequently in 13 study sites, followed by economic factors which were identified as most significant by four study sites (of which two also identified policy/institutional factors as most important). Socio-cultural and knowledge/information factors were considered to be the most significant factor for adoption by stakeholders from one site each.

The sections below provide more details and examples on each of these adoption factors, using the information taken from both EU and study site level stakeholders.

4.1.1 Institutional/policy factors

Institutional factors cover formal structures in which farmers must operate, including binding policy measures (as a way to force behavioural change). Binding regulations are seen by some

[47] Some study sites identified more than one significant factor; thus, the total count is higher than 16.

EU stakeholders as just as effective as financial incentives to bring about change. However, change forced by regulation can be positive or negative: in some cases, it might push the farmers to adopt practices that are good for the soil, in other, it might create adverse effects, albeit inadvertently. At study site level, stakeholders from Flanders provided examples illustrating such behaviour. The predominantly regulatory approach used in the region means that farmers are told what practices need to be adopted, regardless of whether it is feasible economically or practically. Stakeholders noted that this approach often discouraged farmers, and indeed, goes as far as to incentivise adverse behaviour. In the case of legislation on permanent grassland, there have been instances of farmers converting existing grassland to arable land avoid the "permanent grassland" status, which would prevent any conversion in the future.

Complexity of legislation can be another barrier. Another example provided by stakeholders from Belgium referred to legislation on cover crops. One stakeholder claimed that in general, farmers recognised the importance of cover crops. However, by making them mandatory and subject to complex requirements, farmers were quickly discouraged and might dismiss the practice as being too difficult, when in reality, it was something they might have done had the process not been so complex.

Stakeholders further noted that policies were not always up to date, or their revision delayed, causing issues for the adoption of certain practices. One illustrative example comes from Romania, where stakeholders highlighted the need to revise the Code of Good Agricultural Practices for water protection against nitrates pollution from agricultural sources to reflect more accurately the current situation. In Norway, the revision of the Regional Environmental Programme has been delayed twice, which could act as a barrier to implementation as farmers would rather wait for the revision before undertaking any changes to their soil management, for fear that the revision will impact them positively (e.g., they could receive more money under a new scheme) or negatively (e.g. they may be punished under a new scheme for a practice only just implemented).

Stakeholders from several study sites identified instances where SICS adoption was non-coherent with other policy instruments. These inconsistencies can create a difficult environment for farmers to navigate and diminishes the impact of those soil improving policies. In Norway, for example, it was highlighted that a decrease in productivity after SICS adoption would conflict with policies that promote an increase in production – an example was given of the food production strategy (although it was noted that this document is a strategy and not statutory). In Denmark, stakeholders suggested that different policies addressing the same problem created confusion among the farmers. They explained that there were five different cover crops which were covered by different legislation, causing confusion among farmers regarding their specific implementation requirements. Finally, stakeholders from several study sites identified ambitions to increase bioenergy as a major pressure on sustainable agriculture. German stakeholders concluded that subsidies for bioenergy had the potential to promote unsustainable practices and adverse impacts will need to be corrected through a revision of the policy. Feedback provided by UK stakeholders highlighted that targets and subsidies for

increasing woodland areas or growing bio-fuel crops failed to specify that the land must be suitable for these purposes. This could lead to woodland planting on high-grade agricultural soils, or crops grown in unsuitable soil for the crop type or the wrong climate.

Even when the policies favoured sustainable practices, a lack of monitoring and enforcement was mentioned as a significant barrier by stakeholders from most study sites. Stakeholders from the French site emphasized that existing policy should be sufficient to bring about change if it was implemented and monitored correctly. The fact that maize and wheat were used excessively as cover crops in the region, suggested that some control mechanism needed to be put in place to ensure that the policies improved soil quality[48]. They concluded that a weak monitoring regime might act as a barrier to SICS adoption because farmers would soon realise that they could claim the incentive without changing their behaviour. UK stakeholders reported that less than 1% of payment recipients were inspected by the Rural Paying Agency in the UK. They explained that a risk-based approach was adopted, which meant that inspections were carried out where issues were anticipated or had occurred in the past. This meant that potentially farmers were receiving payments without fully undertaking the soil-improving action and could even lead to farmers deliberately gaming the system to take advantage of the lax monitoring. In Switzerland, stakeholder reports suggested that data were not exploited to their fullest potential. As stakeholders explained, there was a fine for soil erosion, but many of the cases went unnoticed. In the same vein, even when the soil samples were analysed, the results were not considered and usually treated as procedural details. In addition, as reports form Czechia indicate, individual inspectors sometimes lacked understanding of the funding requirements, e.g., in the case of the CAP, and stakeholders reported that this has led to an unjustified reduction of subsidies in some cases.

Stakeholders from several sites criticised the lack of soil-specific, binding regulations, highlighting that many soil benefits are delivered as a "by product" of water policy implementation. This was, as explained by Norwegian stakeholders, not in itself a barrier to SICS adoption, but it was perceived as a risk that key soil threats would not be addressed if they did not fall under legislation for other sectors. Stakeholders across sites agreed that there would be benefit in developing soil-specific legislation. Stakeholder feedback collected at the Romanian site emphasised that having a dedicated social policy would be an opportunity to promote and incentivise sustainable soil management practices more consistently across the country.

Finally, findings from the study site suggest that policies shaping agricultural practices are designed and implemented through top-down approaches and are thus perceived as being designed to tell the farmers what to do. Reports from the French study site indicate that this resulted in farmers feeling limited ownership of the policies and therefore decreasing the likelihood of complying with policies. They continued that soil types and physical conditions varied across the country and in order to be successful, policies needed to account for these

[48] Note that the Rural Development Programmes do offer subsidies for farmers who reduce their share of maize, however, the problem persists.

differences and should not rely on one-size-fits-all approaches imposed from the top. This was further illustrated though a reference to the second pillar of the CAP which was viewed as mostly focusing on preserving good practices already in place, again a very top-down approach, leaving very little room for innovation. UK stakeholders confirmed that policies and measures which included farmers in the process - from conception to implementation – were more likely to achieve good results.

4.1.2 Socio-cultural factors

EU level stakeholders emphasised the role of socio-cultural aspects, such as individual environmental attitudes and the mentality of the farming community, play in transitioning to sustainable agriculture. Changing demographics in rural areas across Europe and inter-generational differences within the farming community could create new opportunities or present challenges when it comes to changing farming methods. They noted that, on the one hand, the current generation of farmers was not motivated to take up new systems of farming, given that the next generation was often not interested in taking over existing farming operations. At the same time, they recognised that there was a new generation of farmers returning to their family farms having completed studies elsewhere, often with new ideas and a willingness to change the methods applied by their parents. Stakeholder input collected at the study sites, for instance in Romania, confirmed that young farmers who are educated in the field of agriculture were more open to adopting new soil improving cropping systems than the older generation of farmers. Stakeholders stated that, in the long run, the demographic change in the farming community would increase the uptake of these practices and thus benefit soil quality and soil fertility. This, however, relies on young farmers having access to the profession, which can be difficult in some parts of Europe. In the study site region in Italy, for example, land is passed from father to the first-born son, meaning that farming is essentially closed to newcomers (outsiders). In Switzerland, stakeholders report similar issues, explaining that current policy favoured existing farmers when it came to buying land for farming.

Society's awareness of soil, its multiple functions and how they are valued were further highlighted as important in understanding agricultural management choices. EU stakeholders described the current system of food production as indicative of a view of soil as a resource to be exploited endlessly for economic progress. They concluded that this led to a disconnection of society from agricultural production. In the same vein, there has been an increased 'professionalisation' of the farming practice with farmers spending less time on the field. As a result, there is less farmer engagement with the resources used and fewer opportunities to directly observe changes in soil quality, which might trigger a motivation to preserve soil, and natural resources in general. On the consumer side, the disconnection makes it hard to grasp the complexities and long-term challenges that are facing soil. As a result, a demand for change from the society, which would create pressure on the farmers do not materialise or remains insignificant at best. Stakeholders from several study sites similarly highlighted the need for consumers to better understand the impacts production methods had on soil in order to enable them to make more informed purchasing decisions and increase their willingness to

pay prices reflecting the costs of sustainable production.

EU stakeholders emphasised that attitudes to environmental protection played an important role in the selection of practices employed by farmers and their willingness to transition to sustainable methods. Stakeholders surveyed in several study sites confirmed that farmers were reluctant to abandon traditional practices in favour of new, poorly understood (and often mistrusted) methods. For instance, in Crete, Greece, agriculture, and especially the cultivation of olives, plays a large role in the economy of Crete, and has done so for generations. While retaining its own local cultural traits, the island shapes a significant part of the cultural heritage of Greece. As such, one of the biggest barriers to the adoption of new practices identified by stakeholders was to persuade farmers to consider practices which differed from those generations that came before them. On the other hand, surveyed stakeholders suggested that farmers were more willing to adopt practices seen as preserving traditional forms of cultivation, which might bode well for the adoption of SICS, given that old methods, such as traditionally non-irrigated olive trees were less susceptible to soil erosion than those that are irrigated. reports from Swiss stakeholders highlighted that farmers culturally saw themselves as the ones producing food for people which was a source of pride and identity. If the suggested SICS were likely to decrease productivity in the short term, farmers might see it as a failure, and therefore might be reluctant to adopt these practices. Swiss? Stakeholders concluded that ecosystem services delivered by farmers and the protection of cultural heritage and landscapes though adopting soil-conserving methods needed to be valued more.

Finally, stakeholders from several sites highlighted the relevance of peer pressure for a famer's decision to take up a new practice. Stakeholders surveyed in the Swiss site explained that voluntary economic incentives, such as the existing system of direct payments, might not always guarantee that farmers would take up certain practices as they had to weigh the financial reward against their potentially conflicting interests or personal motivations and attitudes. Stakeholders stated that some of the practices were highly visible to neighbouring farms such as crop rotations or reduced tillage methods. Some of these practices could result in a 'messy' look in the field which might discourage some farmers, as they fear the judgement of their peers, especially if they were the one adopting these practices as one of the first in the region.

4.1.3 Economic factors

Economic factors were frequently identified as both a positive and a negative driver by EU stakeholders. They stressed that farmers, just like any other economic actor, must make a living and make sure there is a stable stream of revenue generated by their activities. This is often seen as an obstacle for change, especially for farmers that are tightly anchored in a conventional system of production that gives them little space of manoeuvre. For example, agricultural outputs might (be expected to) decline following a transition to organic farming, at least in the beginning. This creates a challenging transitional phase which might be seen as a risk not worth taking by the farmers. This is confirmed by evidence collected at the study site level where stakeholders emphasised that, in most cases, growing of a particular crop went

hand in hand with specific machinery and other structural investments. If the farmer decided to invest in another set of crops, they would need to invest in new machinery, which means considerable investment, increasing costs for the farmer. Indeed, stakeholders from the Greek site emphasised that actions that did not have a direct economic impact usually failed and pointed to the high (short and long-term) cost of using organic fertiliser, as well as the costs of equipping machinery with the right tools (e.g., crawlers, disc harrows, brunch cutters), purchase of certain crops like avocado trees and implementing practices such as rotation, planting, and composting.

Stakeholder feedback collected at the study site confirmed the importance of financial incentives to encourage the uptake of certain (desired) practices but most viewed existing schemes as insufficient to facilitate a transition to sustainable practices. The evidence collected indicates that existing financing schemes do not have the desired long-term impacts. Stakeholder reports from Belgium, for instance, highlighted that farmers were likely to revert to old practices as soon as payments were stopped or targeted at new methods or crops, demonstrating the need for a coupling of economic (or other instruments) with softer, informational measures. Other reports point to a lack of specificity of economic incentives. Experiences shared by stakeholders from the French study site suggested that there could be instances where subsidies are promoting practices already in place rather than encouraging farmers to adopt new practices, and it seemed that these subsidies were less focused on including crops that are more beneficial to soil in crop rotations, for example perennial legumes.

Stakeholders across sites agreed that economic instruments should be targeted by policy alternatives, in the sense that specific practices and crops should be targeted with financial support, but also be flexible enough to take into account local conditions and environmental objectives. Stakeholders provided an illustrative example from Portugal where policy encourages the use of cover crops in winter. They noted that in some cases, this measure worked well, for example in Ribatejo or Alentejo, as the main crop (corn) could be collected earlier in the season, and the land was sloping so it drained well, making ryegrass or oats an ideal crop. However, in a valley such as where the study site was located, the ground was usually wet in winter, making the measure less productive.

Stakeholders consulted at both the EU and study site level recognised that the long time frames needed for positive changes to soil quality to occur and become observable, meant that the economic benefits would also take considerable time to materialise. As a result, farmers were more likely to only see (and take into account) the immediate financial costs of changing to a new practice rather than the long-term – soil and financial - benefits. Faced with that choice, farmers tend to favour short-term, less risky, and familiar practices. On the other hand, EU stakeholders noted that a growing demand for organic food created a rapidly growing market which might encourage farmers to move to more sustainable production methods.

Beyond the immediate financial factors, EU stakeholders emphasised that wider structural forces might create overwhelming barriers for farmers. They emphasised that some of these

forces are tightly knit with macroeconomic structures in place and force farmers to follow the business-as-usual practices. In their view, global trade systems often favour large scale food exports based on monocultures, and supply chains then tend to accumulate power in the hands of retailers instead of producers (farmers). Hence, they concluded that current economic systems fail to address externalities of food production, and the overall production chain favours unsustainable practices. Stakeholders in the sites formulated similar views. For example, French stakeholders explained that the current market structure did not value a diversity of crops and neglected the externalities associated with conventional techniques. This meant that farmers were under pressure from consumers to produce specific crops (especially wheat and maize) and sell them at a price that did not necessarily reflect the negative externalities. Without the right economic incentives, farmers were unlikely to maintain SICS in the long term, even if they initially adopted them. 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. Stakeholders even reported their observation that the income generated by intensive agriculture was preferred to the funding available through second the pillar of CAP by farmers. This also means that the more intensive the agriculture in a farm, the less attractive subsidies are for farmers. Specific examples for how market forces drive unsustainable practices were provided by stakeholders from the Belgian site who stated that policy encouraged farmers to plant cover crops and rotate crops. But because of the high demand for potatoes, it was more profitable for farmers to continue growing these crops. In addition, crop residues and organic materials were used for biofuels and other bio-products due to a high demand for these products instead of being returned to the soil. For a farmer, adopting certain SICS would come with lower income revenues.

4.1.4 Knowledge and education

Although not identified as the main factor (positively or negatively) affecting the uptake of SICS, the lack of knowledge – on different topics, including about soil and soil health, of different SICS, their impacts and application - was highlighted as a major barrier hampering the uptake of SICS by stakeholders in all study sites. An example illustrating the positive effects of information exchange on SICS adoptions was reported from Belgium. Here, stakeholders noted that the high use of cover crops in the area was due to good information dissemination, as was the adoption of other practices such as soil ridges? in potato fields and reduction of ploughing depth.

Evidence collected in several sites highlighted the potential of teaming up with trusted organisations to reach farmers. In France, for example, the AEP (*Agriculture écologique performante)*- high performance organic agriculture) groups were mentioned, which were set up and financed by the Brittany regions to bring together people on the ground who have ideas they want to share.

Finally, stakeholders from several sites criticised that information and advice delivered to

farmers was not always impartial. German stakeholders, for instance, reported that farmers' associations had an important influence over the farmers and the decision-making processes but that their communication tools seemed to strongly favour conventional agriculture over new and more sustainable approaches. Because farmers tended to trust their peers more than policymakers and outside experts, this was seen as a potential barrier for the adoption of SICS.

4.2 Which factors affect the adoption of the different SICS?

The findings above are based on an analysis of adoption factors in relation to SICS implementation in general. These results are supported by the outcomes from the adoption workshops carried out in 13 study sites considering the adoption factors of specific SICS trialled in their sites. Practices were grouped together into the following SICS clusters: (1) Fertilisation/amendments, (2) Soil Improving crops, (3) Soil cultivation, and (4) Compaction alleviation.

During the workshop, participants were asked to identify the most important factors affecting the adoption of the SICS tested in the respective sites. **Error! Reference source not found.** shows stakeholder responses broken down by SICS cluster. The following sections briefly summarise the adoption factors per SICS cluster, focusing on those ranked as most important by stakeholders.[49]

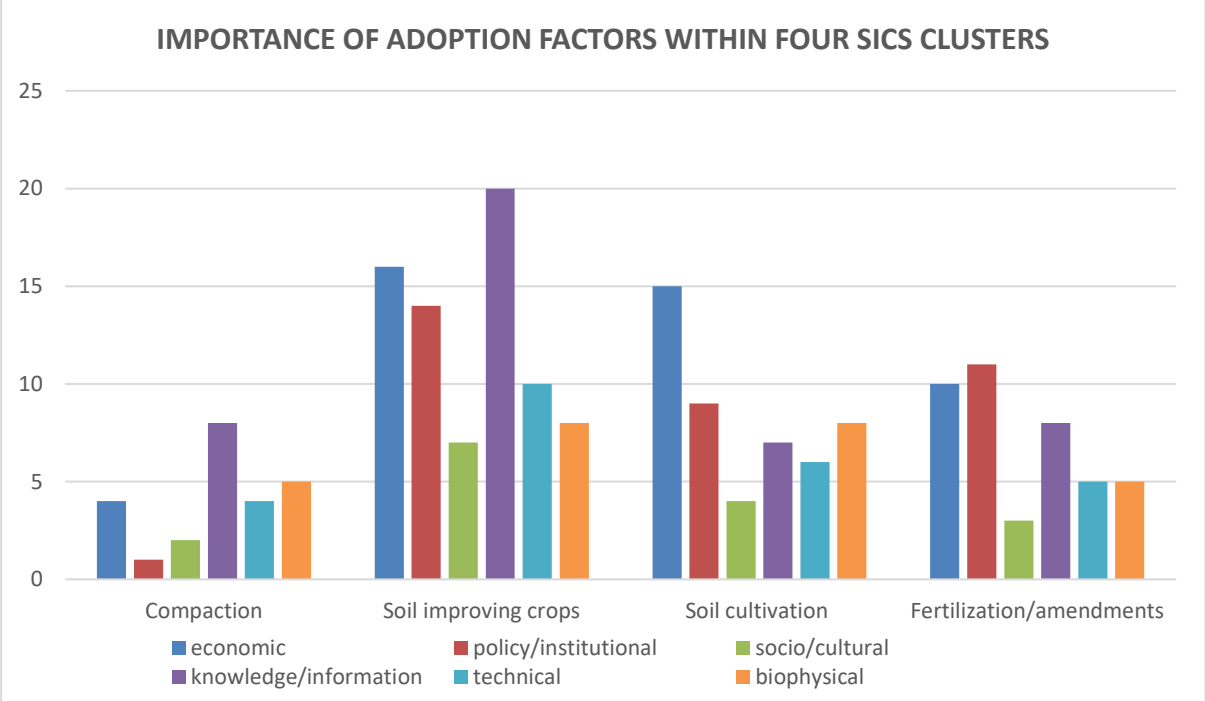


Figure 9: Factors affecting the adoption of SICS Clusters identified by stakeholders during Adoption workshops (all sites).

[49] A more detailed description of the study site findings can be found in the country reports available at https://www.soilcare-project.eu/resources

Fertilisation/amendments

Stakeholders discussing adoption of practices in the fertilisation/amendments cluster identified economic and policy factors as most important, closely followed by information and knowledge sharing. Relevant **policy and institutional barriers** identified by stakeholders in several study sites (BE, CH, PL, CZ) included bureaucratic, lengthy application procedures, complicated and strict legislation, as well as inconsistencies between policies or policy objectives. For instance, in Portugal, where the application of sewage sludge as organic fertiliser was tested, stakeholders reported that obtaining authorisation to apply sludge is a very lengthy process that requires the approval of several entities, which hinders and discourages many farmers from using sludge as a fertiliser. In addition, it was highlighted that the application of sludge was perceived as risky by the public, acting as another deterrent for farmers fearing that consumers might reject their products. Actions are therefore needed to reassure the public and increase acceptance for this practice, including the need to establish treatment standards for WWTP from which effluent is used for applications in agricultural practice. One example from Poland cited the competing interests between the use of crop residues for energy production versus green manure in agriculture.

One of the most frequently mentioned **economic barriers** for the uptake of practices under this cluster was their limited economic attractiveness to farmers (PL, PT and CH). For example, stakeholders viewed the expensive machinery needed to apply the technique tested at the site, fertilisation with Controlled Uptake Long Term Ammonium Nutrition (CULTAN), as prohibitive to farmers. However, stakeholders also identified financial benefits associated with some of the techniques tested. In Portugal, where organic amendments with sludge were trialled, the technique would not involve additional costs for the farmer since sludge could be delivered directly by the operator at no cost. In addition, the use of sludge could reasonably be expected to contribute to increased productivity (and as a result, the farmer's income), due to an improvement in soil fertility and quality.

Workshop participants from four study sites (BE, PL, PT and CH) concluded that a lack of **knowledge and information**, particularly the limited experience with the application of the different fertilisation techniques trialled in SoilCare as well as understanding of their long-term benefits hindered their wider uptake. Actions suggested to remove this barrier focused not only on the provision of more information and training opportunities but also the establishment of demonstration site to illustrate the application of the trialled methods within local conditions.

The table below lists all factors influencing the adoption of SICS grouped under the fertilisation/amendments cluster. Experiments are added in brackets the first time a study site country is listed.

Table 11: Factors affecting the adoption of SICS grouped under the fertilisation/amendments cluster

Adoption enablers (+) and barriers (-)	Study site
Economic	
Expensive modern machinery for sustainable soil cultivation, e.g., conservation tillage equipment (-)	CH (Fertilisation with CULTAN) PL (Cover crops, liming, manure

Sufficient supply of woodchips (-)	BE ("Wood chips")
Costs of implementation (-)	BE
Low cost for farmer (+); extraction of ammonia from sewage treatment plants will reduce the prices (+)	PT (Organic amendment with sludge) CH
Policy/institutional	
Strict legislation (e.g., Nitrates Directive in CZ and Sewage Sludge legislation in PT; and high level of bureaucracy, e.g., for sludge application permits	CZ (Manure; catch crops and growing legumes) PT
Possibility of management agreements (VLM) (+)	BE
Inconsistencies in the legislation (-), e.g., energy v agriculture policy - the use of harvest residues for biogas production competing with the use in agriculture	BE, PL
Principles of Agricultural Crop Fertilisation in Switzerland (PRIF), organic suitability (-)	CH
Knowledge/information	
Awareness and knowledge of advantages (+) **Easy access to information (+)**	BE, PT
Low level of knowledge amongst farmers to support SICS adoption (-), e.g., lack of knowledge about the sludge application or the environmental benefits (-)	PL, PT, CH
Biophysical	
Extreme weather patterns (droughts, irregular rainfalls) (-)	CZ (
Homogeneous and raw soils, flat roots, legumes (+)	CH
Stony soils, compacted soils, dry soils, taproot (-)	CH
Sulphur content (-)	CH
Socio/cultural	
Bad reputation of sludge application amongst the public and farmers (-)	PT
Technical	
Cooperative purchase of machinery possible (+)	BE
Precise fertilisation (+)	CH
Yeast concentration, working width, material quality, need specialist for the injection (-)	CH
Limited access to organic fertilisers resulting from the separation of agricultural and livestock production (-)	PL
Bad smell of sludge	PT

Soil-improving crops

Knowledge and information sharing followed by economic and policy /institutional factors are considered as having the most impact on the uptake of practices tested in this cluster. Socio-cultural factors seem to play only a minor role according to workshop participants' views.

Knowledge and education, particularly the need for wider dissemination of information and peer-to-peer learning to facilitate wider uptake of soil-improving crops was recognised by stakeholders across study sites (PT, UK, ES, NO). Stakeholders generally emphasised the effectiveness of learning and knowledge exchange in challenging and changing farmers' misconceptions about certain practices preventing them from moving towards sustainable techniques. Stakeholders in all sites under the cluster noted that training in green fertilisation was missing, and that farmers had very little knowledge about new/alternative crop varieties and methods. Participants in the Portuguese and Norwegian workshops specifically highlighted that knowledge on how to implement soil-improving crops under local conditions was scarce.

Similarly, workshop participants from all study sites identified **economic factors,** particularly investment and operational costs, costs as hampering the adoption of soil-improving crops.

For instance, in Portugal the costs for planting Lucerne (as part of the crop rotation with rice) and in Greece, the costs for purchasing Avocado trees (to replace orange orchards) were identified as prohibitive for farmers. The need to buy seeds on top of the main crop when using cover crops were other costs identified as discouraging to farmers (e.g. NO). Stakeholders in all sites therefore highlighted the need to increase payments to farmers to compensate higher operational costs and to reward the environmental benefits delivered by adopting SICS. At the same time, workshop participants pointed out the savings which e.g. cover crops could bring since their use is likely to reduce the need for fertiliser. Communicating both the costs and benefits of adopting SICS under this cluster, combined with targeted incentives, could therefore help to increase the number of farmers using soil-improving crops. Indeed, stakeholders from Norway and the UK noted that existing economic incentives were not targeted enough to affect the desired change. UK stakeholders made the case that the continued cultivation of crops in unsuitable conditions may indicate that the market for these crops exceeded sustainable demand (high demands from food chains and supermarkets). This situation could be potentially mitigated by addressing the market failures through economic instruments. By encouraging sustainable crop placement (for example through a subsidy) or discouraging a harmful one (for example through a tax or tariff), the food chains or supermarkets would be guaranteed their supply, while ensuring that the prices offered by supermarkets are not disproportionately attractive to farmers.

In terms of **policy and institutional** drivers, stakeholders emphasised the need for stronger monitoring and enforcement mechanisms to ensure that existing policies promoting the use of cover crops are more effectively implemented (FR, UK, ES). As explained in the section above, stakeholders critisiced that current economic incentives were not flexible enough to take into account regional differences (e.g., PT). Finally, lack of coherence between policies, or better, conflicts between policy objectives were identified as barriers for the uptake of soil-improving crops. Feedback received from the UK site highlighted, for instance, that some soil-improving crops might reduce yield which would not be in line with the national goal of increasing food production.

Findings suggest that biophysical, technical, and socio-cultural factors are thought to play a minor role for the adoption of soil-improving crops. It is, however, worth highlighting that stakeholders pointing to climate conditions, and specifically the length of the growing season as an important factor for the adoption of soil-improving crops, indicates that some SICS under this cluster might be more suitable to certain climatic regions.

The table below lists all factors influencing the adoption of SICS grouped under the soil-improving crop cluster. Experiments are added in brackets the first time a study site country is listed). Where factors apply to different experiments in individual sites, they are explicitly listed.

Table 12: Factors affecting the adoption of SICS grouped under the soil-improving crops cluster

Adoption enablers (+) and barriers (-)	Study site
Knowledge/information	
Lack of training in green fertilisation; insufficient knowledge about new/alternative crop varieties and	PT (Legumes green manure), EL (Conversion from orange orchards to avocados), ES (Deficit irrigation/ adventitious

Adoption enablers (+) and barriers (-)	Study site
methods (-)	herbs/plant cover planted), ES (Deficit irrigation/mulch cover with pruning remains and vegetable coverings sown), FR (Early sowing of wheat, cover crops, interseeding cover crops), DE (Cover crops)
Difficult to access relevant information and experience for application under local conditions (-)	PT (Legumes green manure), NO (Cover crops- catch crops)
Limited knowledge of costs/benefits (-)	UK (Grass leys in rotation), EL (Cover crops organic vineyards) ES (Deficit irrigation/ adventitious herbs/plant cover planted)
Lack of awareness about financial support (-)	UK
Lack of knowledge about soil (-)	UK
Positive experiences with advisory services and farm visits (+)	NO
Economic	
Lack of subsidies (-)	PT (Legumes green manure)
Cost and access to seeds (-)	PT (Legumes green manure), NO, DE
Crops grown at unsuitable places due to high market demand (-)	UK
Cost for organic certification in small areas, organic fertilisation and labour (-)	PT (Organic rice in rotation with Lucerne)
Costs of new practices in the short and long-term, e.g. high cost of installing lucerne in PT or purchase of avocado trees in EL (-)	PT (Organic rice in rotation with Lucerne, EL (Conversion from orange orchards to avocados), FR, ES (both experiments)
Subsidies in place, e.g., for rice cultivation in PT (+)	PT (Organic rice in rotation with Lucerne), NO
Economic value underestimated (-)	PT (Organic rice in rotation with Lucerne)
High provision of inputs (+)	ES (Deficit irrigation/ adventitious herbs/plant cover planted)
Design of subsidy schemes limiting use of certain types of seeds, methods, and dates for sowing due to policy design (-)	NO
Reduced need for fertilisers (+)	DE
Policy/institutional	
No political incentives to adopt the green manure technique (-)	PT (Legumes green manure,) EL (Conversion from orange orchards to avocados)
Lack of legislation protecting the soil (-)	UK
Lack of monitoring and enforcement for funding schemes (-)	UK, FR, ES (both experiments)
Conflicts with objective of increasing food supply (cereal yield decline at catchment scale) (-), Lack of coherence between policies (-)	UK, FR
5-year rule for permanent pastures (-)	UK
Stewardship scheme prevents conservation of forage(-)	UK
Policy support for organic rice cultivation (+)	PT (Organic rice in rotation with Lucerne)
Top-down policy design (-)	FR
Socio/cultural	
Lack of farmer interest and supportive networks (-)	PT (Legumes green manure)
Might not be attractive to wholly arable farmers (-)	UK
Resistance to change (mentality of farmers) (-)	EL (Cover crops organic vineyards), ES (both experiments)
New generation of farmers open and interested to try this technique (+)	PT (Organic rice in rotation with Lucerne)
Biophysical	
Favourable climate (+), and changing climate resulting in longer growth season, e.g., in NO (+)	PT (Legumes green manure), EL (Conversion from orange orchards to avocados), NO
Soil conditions (+)	PT (Organic rice in rotation with Lucerne), FR (Early sowing of wheat, cover crops, and interseeding cover crops in maize)
Water scarcity (-)	ES (Deficit irrigation/mulch cover with pruning remains and vegetable coverings sown),
Biodiversity enhancement; sustainable technique (+)	DE
Technical	

Adoption enablers (+) and barriers (-)	Study site
May offer blackgrass control measure (+)	UK
Weed management (more pests attacking organic rice) (-)	PT (Organic rice in rotation with Lucerne)
Technical support from cooperatives, open days (+)	PT (Organic rice in rotation with Lucerne)
Access to technology / machinery (-)	ES (Deficit irrigation/ adventitious herbs/plant cover planted)
Plant cover selection (-)	ES (Deficit irrigation/ adventitious herbs/plant cover planted)
Size of exploitation (-)	ES (Deficit irrigation/mulch cover with pruning remains and vegetable coverings sown),
Crop rotation management complicated e.g., establishment and timing of tillage must be precisely timed (-)	DE

Soil cultivation

In this cluster, stakeholders considered economic factors as the most significant adoption factor. Stakeholders from across sites pointed out the need for new and more specialised (expensive) machinery to implement some of the tested practices (BE, DE, and CZ). It was suggested to cover these investment costs through grants, or through the establishment of machinery exchanges where farmers share equipment to reduce costs. In addition, stakeholders indicated that e.g., reduced tillage practices might lead to higher costs for pesticides at lower yields (in some locations). At the same time, stakeholder recognised that these practices would reduce fuel costs and labour costs.

A lack of policy enforcement and monitoring was brought up as an adoption barrier by some stakeholders in this cluster. Workshop participants in Spain, for instance, explained that an effective monitoring and banning of harmful (and non-compliant) practices such as stubble burning, was urgently needed.

Stakeholders identified several biophysical factors which limited the adoption of the SICS grouped under the coil cultivation cluster. Examples provided were extreme weather patterns (droughts, irregular rainfalls) in Czechia where different tillage methods were tested, geomorphological conditions such as steep slopes, stones, and rocks in Greece (no tillage) and water scarcity in Spain (controlled deficit irrigation). In contrast, some sites identified favourable natural conditions, such as Germany, where the heavy soil are assessed as particularly suitable to the reduced/no tillage practices trialed at the site.

The table below lists all factors influencing the adoption of SICS grouped under the soil cultivation crop cluster. Experiments are added in brackets the first time a study site country is listed. Where factors apply to different experiments in individual sites, they are explicitly listed.

Table 13: Factors affecting the adoption of SICS grouped under the soil cultivation cluster

Adoption enablers (+) and barriers (-)	Study site
Economic	
Need for new machinery (-)	CZ (Tillage experiments), BE ("Grass undersowing"), DE (Reduced/no tillage)
High provision of inputs (+)	ES (Controlled deficit irrigation and vegetative cover of adventitious herbs/plant cover planted)
Lower yield in some conditions (-)	BE ("Grass undersowing"), DE (Reduced/no tillage)
Increased need for pesticides (-)	BE ("Grass undersowing"), DE (Reduced/no tillage)

Reduced fuel consumption, reduced workload (+)	DE (Reduced/no tillage)
Impact of market forces, particularly on glyphosate debate (-)	DE
Operational costs (-)	ES (Controlled deficit irrigation and mulch cover with pruning remains and vegetable coverings sown)
Policy/institutional	
Promotion of organic farming with derogations from the ploughing ban (-)	DE (Reduced/no tillage)
Lack of enforcement and monitoring (-)	ES (both experiments)
Biophysical	
Extreme weather patterns (droughts, irregular rainfalls) (-)	CZ
Erosion prevention (+)	BE
Prevention of soil compaction (+)	BE
Heavy soils can be cultivated (+)	DE
Decreased erosion (+)	DE
Geomorphological conditions (steep slopes, stones, and rocks (-)	EL (Tillage/no tillage in olive orchards)
Water scarcity (-)	ES (Controlled deficit irrigation and mulch cover with pruning remains and vegetable coverings sown)
Knowledge/information	
Lack of awareness and information (-)., e.g., Dissemination of efficiency potential as wind erosion control (+)	ES (both experiments), EL, DE
Lack of training for farmers (-)	ES (Controlled deficit irrigation and vegetative cover of adventitious herbs/plant cover planted
Socio-cultural	
Societal demand for sustainable products (+)	DE
"It looks wild"; pest management not possible without chemical plant protection (-)	DE
Farmers' resistance for new practices (-)	ES (both experiments)
Technical	
Crop rotation management is complicated (-)	DE
Application of practice on stony soils (-)	DE
Lack of access to technology and machinery (-)	ES (both experiments) Cover crops and enhanced efficiency irrigation: Controlled deficit irrigation and mulch cover with pruning remains and vegetable coverings sown
Size of exploitation (-)	ES (Controlled deficit irrigation and mulch cover with pruning remains and vegetable coverings sown)
Plant cover selection (-)	ES (Controlled deficit irrigation and vegetative cover of adventitious herbs/plant cover planted)

Compaction alleviation

In this cluster, stakeholders view information and knowledge sharing as the most influential factor for SICS adoption. The frequency with which other factors were mentioned did not suggest that one type of factor was perceived to be more important than another.

A lack of knowledge of farmers on multiple levels was brought up by stakeholders from different sites (NO, UK and CH). Firstly, evidence suggested that there was a need to showcase the benefits of SICS to farmers through for example farm walks and organised study trips to learn from others' experience. Secondly, more training courses should be provided to farmers to educate farmers about the practical application of the tested methods. In the UK, for instance, it was highlighted that there was limited experience with ploughing and subsoiling techniques in combination with the inoculant tested at the site. In Switzerland, stakeholders explained certain crops commonly found in Switzerland, e.g., sugar beet, necessitated

extremely heavy machines and were harvested in wet periods exacerbating the problem. Farmers might consider their machinery as unnecessarily big but were not given appropriate advice on alternatives. Previous exposure to compaction damage might motivate farmers to seek information and training on compaction alleviation measures, as pointed out by stakeholders from Norway. Similarly, UK stakeholders thought that the fact that subsoiling was a known practice in the region could promote the uptake of the tested SICS.

Some stakeholders pointed out limiting soil conditions, such as in the UK, where the ploughing and subsoiling techniques were considered to be unsuitable for shallow/stony soils. Access to specialised machinery (GPS, light machines etc.) was highlighted as a potential technical barrier by feedback collected at the UK and the Swiss sites, pointing to a potential financial obstacle for adopting some of the tested techniques.

Finally, only evidence collected from the Swiss site points to the policy context as hampering the uptake of compaction alleviation SICS. Stakeholders criticised that soil compaction was one of the biggest challenges to soil quality in Switzerland. However, policy did not seem to give enough attention the issue. For instance, a rule on maximum weight of machinery was lacking in the agricultural sector.

The table below lists all factors influencing the adoption of SICS grouped under the compaction alleviation cluster. Experiments are added in brackets the first time a study site country is listed.

Table 14: Factors affecting the adoption of SICS grouped under the soil cultivation cluster

Adoption enablers (+) and barriers (-)	Study site
Knowledge/information	
Experiences with compaction damage (+)	NO (Biological compaction release)
Lack of information (-)	NO
Lack of knowledge transfer (-)	CH
Limited knowledge of costs/benefits (-)	UK
Lack of knowledge of practical application in combination with inoculant (-)	UK
Sub-soiling acceptable agronomic / known practice (+)	UK
Biophysical	
Improved soil activity (less compaction) (+)	CH (Green verges)
Green strips (always passable) (+)	CH
Not applicable to all soils (shallow/stony soils) (-)	UK (Plough, sub-soiling, and mycorrhizal inoculation)
Economic	
More yield with less effort, incl. manuring input (+)	CH
Need for special equipment (-)	CH, UK
Policy/institutional	
Lack of weight limitations for machinery in legislation (-)	CH
Socio/cultural	
Implementing new ideas needs interest and time of the farmer, willingness to take risks (-)	CH
Technical	
Takes time for effects to be visible (-)	CH
Effort/practicability (-)	CH
GPS required (1x per sowing), width of parcel, material quality (e.g., light machines) (-)	CH
Availability of equipment needed (-)	UK

5 Facilitating the uptake of Soil-Improving Cropping Systems

Based on the analysis of the policy framework at EU, national, and sub-national level, and feedback collected from European and national stakeholders, we can formulate a set of overarching recommendations for policy alternatives.

This section presents these recommendations, identifying specific actions for the European and national level, and specifying, where appropriate, measures to promote the uptake of specific SICS. Recommendations formulated for the different study site countries, and the specific SICS tested at these sites, are annexed to this report (Annex II).

The recommendations were refined based on the feedback from the stakeholders at an EU level workshop held on May 2021. They were presented to the participants of the final policy meeting that took place June 2021. The recommendations aim at providing additional perspectives to the upcoming discussions on the new Soil Strategy and the Nature Restoration Targets.

Recommendation I: Define long-term ambitions and targets

Develop horizontal, long-term strategies for sustainable agriculture: strategic vision going beyond short-term political interest has great potential to facilitate a transition to sustainable agriculture and thus better soil management practices. In the same vein, policies should aim to be more holistic and include long-term targets considering the long timeframes often needed for benefits to materialise (especially when looking at soil health impacts). Different priorities put forward by policies over time can create undesirable effects which are sometimes difficult to remedy. An example cited by national stakeholders was the focus on modernisation of farming in the last decades which led to practices that are today considered unsustainable.

At the EU level, the European Farm to Fork Strategy provides a starting point for developing such a vision at European level.

At the country level, key aspects of the Farm to Fork strategy could be further developed and adapted to create a national vision for sustainable agriculture with key steps developed to meet these ambitions. National processes for implementing the Agenda 2030's Sustainable Development Goal could further provide a formal framework for formulating such a vision.

Raise and clearly define the level of ambitions in existing policies: There is a general lack of ambition regarding policy targets and measures, especially in the CAP, which is further undermined by a lack of rigorous implementation. This includes inter alia counter-productive incentives such as hectare-based payments under Pillar 1 since payments should be based on performance against clearly defined objectives delivering from, among others, soil benefits. The greening measures should go beyond cross-compliance and those already included in AECMs (agri-environmental climate measures). Under Pillar 1, the choices of farmers for implementing different EFA (Ecological Focus Areas) measures indicate that less ambitious choices are made, which are less effective for promoting biodiversity - for example nitrogen

fixing crops, wind cover, and catch-crops are chosen instead of EFAs like landscape features. These shortcomings in policy design should be addressed so EFAs can deliver real environmental benefits. Under the Rural Development Programs, agro-environmental measures should be strengthened to deliver more specific soil benefits (such as M10) with more ambitious use. This involves the development of clear, action-oriented targets, set out below.

The new CAP does not remove hectare-based payments but does try to increase the ambition by introducing enhanced conditionality and eco-schemes. However, there is still little emphasis on the monitoring of environmental benefits. Providing more flexibility to Member States, as the 2018 CAP proposal envisages, to define their own targets is potentially beneficial to the design of context-dependent measures, however, the lack of clearly defined objectives undermines the ambition required from the CAP. The CAP proposal suggests incorporating EFAs into GAEC 9, which means they will be applicable to all farms. But again, monitoring of performance in terms of environmental impacts remains a problem.

At the country level, Member States are encouraged to take the opportunity of designing eco schemes that clearly go beyond cross-compliance to meet environmental targets. In addition, contracts provided for farmers (under RDP measures or the new eco schemes) should cover longer time periods to provide more stability for farmers. This also applies to the design of funding schemes which would allow farmers long-term planning.

Define binding soil targets and promote sustainable practices through either dedicated soil policies or mainstreaming of soil objectives in existing and new environmental/sectoral policy instruments

The protection, maintenance, and improvement of land and soil at EU level as well as in the countries covered by this study relies heavily on sectoral and environmental policies. Furthermore, not all soil threats are equally well targeted by existing instruments. Stakeholders approached for this study identified the need for legislation focusing on soil for a more direct impact on farming practices. They explain that having only general instead of soil-specific regulations has only a limited impact, failing to integrate different aspects relevant soil health such as water, waste, nature and energy. While this is not necessarily a barrier to SICS adoption, there is a risk that key soil threats are not addressed if they do not fall under legislation for other sectors. In addition, analysis of the benefits of these SICS in relation to the existing policy framework at European level shows that many of these approaches can actively contribute to meeting the objectives of EU legislation. Our research also demonstrates how SICS may play a part in reaching the Sustainable Development Goals.[50]

At the EU level, actions could include:

- Developing specific targets for different pressures affecting soil functions/causing soil

[50] See SoilCare Policy Brief "Soil health policies towards Sustainable Development Goals, available at: https://www.soilcare-project.eu/resources/resources-for-policy-makers/42-resources/236-policy-briefs

threats for integration in new policy initiatives, such as the ongoing revision of the Soil Thematic Strategy, or the Zero Pollution Action Plan.

- Build on the SDGs, particularly target 15.3 which establishes the objective of land degradation neutrality by 2030.
- Promote SICS through relevant strategic and sectoral policies, including the new Soil Thematic Strategies, EU-level advice on Eco Schemes as well as Commission recommendations issued to the Member States within the context of the formal review and approval process of the new Cap Strategic Plans.

At the country level:

- Relevant SICS could be incentivised through measures in the CAP Strategic Plans, and particularly the Member States' Eco Schemes.
- Stakeholders, particularly farmers should be involved in the development of national and sub-national policy instruments. The Farm to Fork Strategy explicitly calls for strengthening the position of farmers in the supply chain, and the procedures for drafting national CAP Strategic Plans ask for a wide consultation process.

Recommendation II: Increase coherence and exploit synergies between policies more effectively

There are many different pieces of legislation which can work better together if coherence and integration between them is improved: Cross-compliance addresses soil quality through GAECs which are not necessarily integrated with other cross-compliance measures such as the Statutory Management Requirements related to the Nitrates, and Birds and Habitats Directives.

In addition, stakeholders noted that some soil-improving practices might not align with existing policy objectives. For example, a reduced yield (but increased soil quality) contrasts with the aim of increasing food production. By the same token, some policy objectives foster unsustainable agricultural practices - for instance, stakeholders frequently identified conflicts between agricultural production and biomass production for renewable energy.

At the EU and country level,

- Policy conflicts and synergies need to be carefully analysed and aligned, so as not to discourage the transition to sustainable farming practices. Ultimately, this might require a prioritisation of certain objectives and targets (and operationalised by the right policy interventions) as a certain level of conflict is unavoidable given potentially conflicting needs of between environmental, social, and economic sustainability. The new CAP proposes changes to improve the overall coherence of CAP with other, but mainly environmental legislative instruments. Potential conflicts with other sectoral legislation remain.
- Mechanisms to ensure coherence between different legislation and policy can include future looking impact assessments which integrates soil health as a fundamental

element. This means all relevant legislation would go through a set of criteria to determine whether they have an adverse impact on soil either directly or through encouraging unsustainable farming practices.

- Stakeholders emphasise that highly complex legislation and a lack of policy coherence fail to inspire adoption. On a practical level, it is important for farmers to have clear, unambiguous information on the legal conditions they need to comply with – especially if they are tied to subsidies - and those that may be rewarded.
- A two-way communication between the policy makers, the farmers and the neutral advisory services would help to create a constant feedback loop, overcoming some of the clarity issues and avoid top-down policy design. Permanent platforms for exchange involving diverse representatives of farmers, other actors and policy makers can be envisaged both at EU and country level.

Recommendation III: Design targeted (economic) instruments that facilitate a transition to sustainable practices and reward environmental benefits delivered

Evidence suggests that regulation is seen by many farmers as punishing rather than rewarding. Stakeholders noted that the CAP, as the financial instrument shaping farming across Europe, should strive to be less prescriptive, avoiding one size fits all approaches but provide the farmers with a general direction, clearly defined by targets and empowering them to take steps towards these targets in a way that is best adapted to their unique circumstances. There is potential to develop economic instruments further, as costs are seen as the key barrier to SICS adoption – whether they are direct costs (such as investing in new machinery) or opportunity costs (such as foregoing revenue from potatoes or biomass). The cost of transition to more sustainable practices is identified as an important barrier for the farmers. Forced to choose between short term and long-term gains, farmers often have no real motivation to forego their immediate revenues. The uptake of certain SICS, such as reduced tillage or cover crops might require upfront investments, such as the purchasing of additional seeds and new machinery.

At the EU level, the new set-up proposed for the post 2020-CAP give Member States a higher degree of freedom when it comes to defining the new CAP Strategic Plans. It will be up to the Member States to define suitable instruments to support ambitious action at the farm level.

At the country level,

- Member States should ensure that financial instruments facilitate the transition to long-term change in practices rather than finance one-off interventions. Grants should be made available to farmers (or groups of farmers) buying new equipment to implement sustainable practices.
- There is a need to consider the different conditions in which farmers operate (such as differences in tenure) to ensure funding is accessible without creating additional administrative burden. Furthermore, incentives must be adapted to changing

conditions such as inflation, so they do not lose their attractiveness over time.

- Measures need to be flexible enough to allow for regional differences. A financial measure on cover crops may well be appropriate in one part of a country, but less appropriate in another. Financial incentives need to be more targeted, both tied to specific actions and region (or environmental/geographic conditions) to result in the desired change.
- Priority should be given to conservation farming techniques that are also able to be a source of food production that is both profitable and sustainable. For example, a subsidy could be tied to the use of a specific crop or crop change. The new CAP opens up opportunities to review and broaden the practices and environmental benefits farmers will need to deliver in order to receive payments. Cropping systems which produce important benefits such as sequestering carbon and which are currently not covered by subsidies, could be added to the measures available to farmers applying for CAP payments.
- Funding should be easily accessible by simplifying application process. Evidence suggest that economic incentives might not be a key driver for SICS adoption with the current system perceived to be overly bureaucratic by farmers. The payment agencies should seek to simplify procedures for farmers applying for CAP payments in order not to deter farmers from adopting SICS. However, control mechanisms and monitoring must be robust to prevent abuse.
- In addition, market instruments can be used to counter the impacts of the current food production systems which prioritise short-term economic gains. Taxation for unsustainable products and techniques at consumer level is a way of internalising the costs on the environment and wider society and would also influence consumers' choices, creating more demand for sustainable products, giving them the price advantage.
- Policies can be designed to encourage innovative financing schemes for funding and running sustainable farms. Crowdfunding seems to be effectively used for diverse purposes in different policy fields and can also be effective in bringing change to farming practices.
- Non-financial economic instruments are also important and should be taken into account when designing policy. For instance, schemes for sharing equipment and/or collective buying which would be otherwise expensive can be created, encouraged and promoted among the farmers. Stakeholders from the industry can be encouraged to take part in these schemes to promote their equipment/material.

Recommendation IV: Strengthen monitoring and enforcement

It is acknowledged that whilst the CAP has the potential to deliver real impacts, it is undermined

by a lack of proper implementation, control, and sanctions or penalties for non-compliance. For instance, greening payments may only be fully effective if infringement is penalised by withdrawing or paying back direct payments. In the context of the CAP, monitoring is hampered by the absence of specified indicators on compliance and clearly defined cross-compliance objectives. More robust monitoring and enforcement of policies will provide more clarity for farmers and will also provide evidence that the measures are working, encouraging further uptake of some practices. This is especially important in a context where farmers benefit from peer learning and rely on the experience of other farmers. Policies are viewed by stakeholders as complicated, incoherent, and poorly enforced. This makes it challenging for farmers to comply with policy requirements, especially if they observe that they face little consequence for non-compliance.

At the EU level, there is a need to establish a clear, robust, and reliable monitoring and enforcement system for the CAP. Whilst the new CAP proposal includes a detailed set of indicators, they mainly focus on establishing target areas/proportions which should be covered by a specific measure rather than define environmental improvements that should be achieved at farm level. Another important feedback involves streamlining different monitoring systems set up for different legislation. To create integrate systems for these separate processes can greatly enhance reliability and reduce administrative burden on public authorities.

At the country-level, stronger monitoring and enforcement systems require the training of farm inspectors who, like farmers, need to understand the regulatory requirements and their practical implementation. Additionally, stakeholders acknowledge the potential benefits of a dedicated unit within the governments specifically focusing on monitoring soil health. This should be accompanied with sufficient resources for operation and enforcement.

Recommendation V: Strengthen existing and establish new opportunities for learning and knowledge exchange for farmers

Financial incentives such as those established by the CAP may be less effective than other types of instruments such as provision of information and advisory services, as they do not consider factors relating to farmer views and attitudes. Personal convictions of farmers play a key role in the adoption of new practices, and information and educational measures are therefore key to facilitating a transition to agricultural practices that benefit soil health.[51]

Strengthen the capacity of Farm Advisory Services: Farm Advisory Services are valuable sources of information for the farmers, but their independence and neutrality should be ensured. Like farmers, advisors also need to learn about new practices, their practical application, costs, and benefits to support farmers they assist.

Support of Fam Advisory Services, e.g., though CAP instruments, therefore, needs to continue.

[51] See also Rust NA, Ptak EN, Graversgaard M et al. Social capital factors affecting uptake of sustainable soil management practices: a literature review [version 2; peer review: 2 approved]. Emerald Open Res 2020, 2:8 (https://doi.org/10.35241/emeraldopenres.13412.2)

At country-level, technical skills of farm advisory services need to be strengthened through governmental support to ensure that the advice delivered reflects current knowledge and remains impartial.

Inform and educate farmers about new developments and insights. Dissemination of knowledge, awareness raising, and education are important components of policy interventions, and they should be used in parallel with economic and legislative instruments.

At the country level,

- Make soil health a stronger component of vocational training and continued education of farmers. The move from conventional practices to SICS and sustainable agricultural practices requires a shift in attitudes as well as knowledge. Soil, as the main medium on which food and feed are grown, should feature highly on the curriculum for farmer training, be it basic vocational or continued adult learning. It should also underline the basic principles of sustainability such as generational fairness, the importance of soil health for all other systems on the planet and the impacts of unsustainable practices. Farmers also need to be shown how to observe and measure soil changes – using simple methods and instruments - to make the benefits of SICS adoption visible in the short-term (where possible).
- Establish regular training, informative sessions on latest innovations are preferred to one off training sessions which have limited impact. Some of the practices benefitting soil will require farmers to learn about these techniques, their application to different conditions as well as their benefits in order to change any misconceptions about these methods. Stakeholders suggest that well-organized and continuous interactions with farmers such as free group talks are successful in bringing change in attitudes and beliefs.

To effectively share information and knowledge, advisory services should

- Engage with farmers and trusted organisations to deliver advice and training. Peer to peer learning and bottom-up initiatives are powerful tools to deliver knowledge to farmers as they play a great degree of trust in their fellow producers. Partnering with farmers willing to pioneer new techniques or trusted organisations, will ensure that target audiences are reached, and new information is heard. Stakeholders involved in the SoilCare project provided many examples of successful voluntary initiatives that are considered very effective in changing convictions and practices. Among those, farmers' groups are especially important. Such groups have a greater success of convincing farmers to adopt SICS for several reasons and can help demonstrate how to adapt practices and targets to specific geographic or other constraints, which may make SICS adoption more attractive to farmers in the region.
- Collaborate with scientists and other researchers to promote innovation which would optimise technologies to allow farming to become more sustainable across the board

and to make research findings accessible and ensure their wide dissemination

- Disseminate knowledge via multiple channels, through the provision of guidance document but also through farms visits and demonstration days. A recurrent suggestion is to identify lighthouse projects and disseminate them across a wider community of farmers.
- Consider the establishment of a network of model farms demonstrating how to use and adapt different SICS in the region.
- Engage with a wide demographic, ideally using tailored methods for delivering advice. Younger farmers seem to be willing to take up new practices, and it is important to reach older generations as well.

Information and knowledge shared should:

- Explain the costs and benefits of new practices. The advantages and disadvantages of the soil-improving cropping systems trialled at the study site are poorly understood by farmers. They should be widely communicated, and ideally demonstrated with field visits, to farmers in the region, by the advisory services, farmers with first-hand experience with these techniques, and other organisations trusted by the farming community. Similarly, when adoption practices do not go as planned and are subsequently deemed a failure, the causes need to be systematically investigated and documented to shape future initiatives.
- Be coherent and clear and avoid giving conflicting and confusing messages.
- Provide up-to-date information on policy requirements, and administrative procedures:
- Report findings from research projects, such as SoilCare, as well as conclusions from long-term field experiments with the region.

Finally, both at the EU and country level,

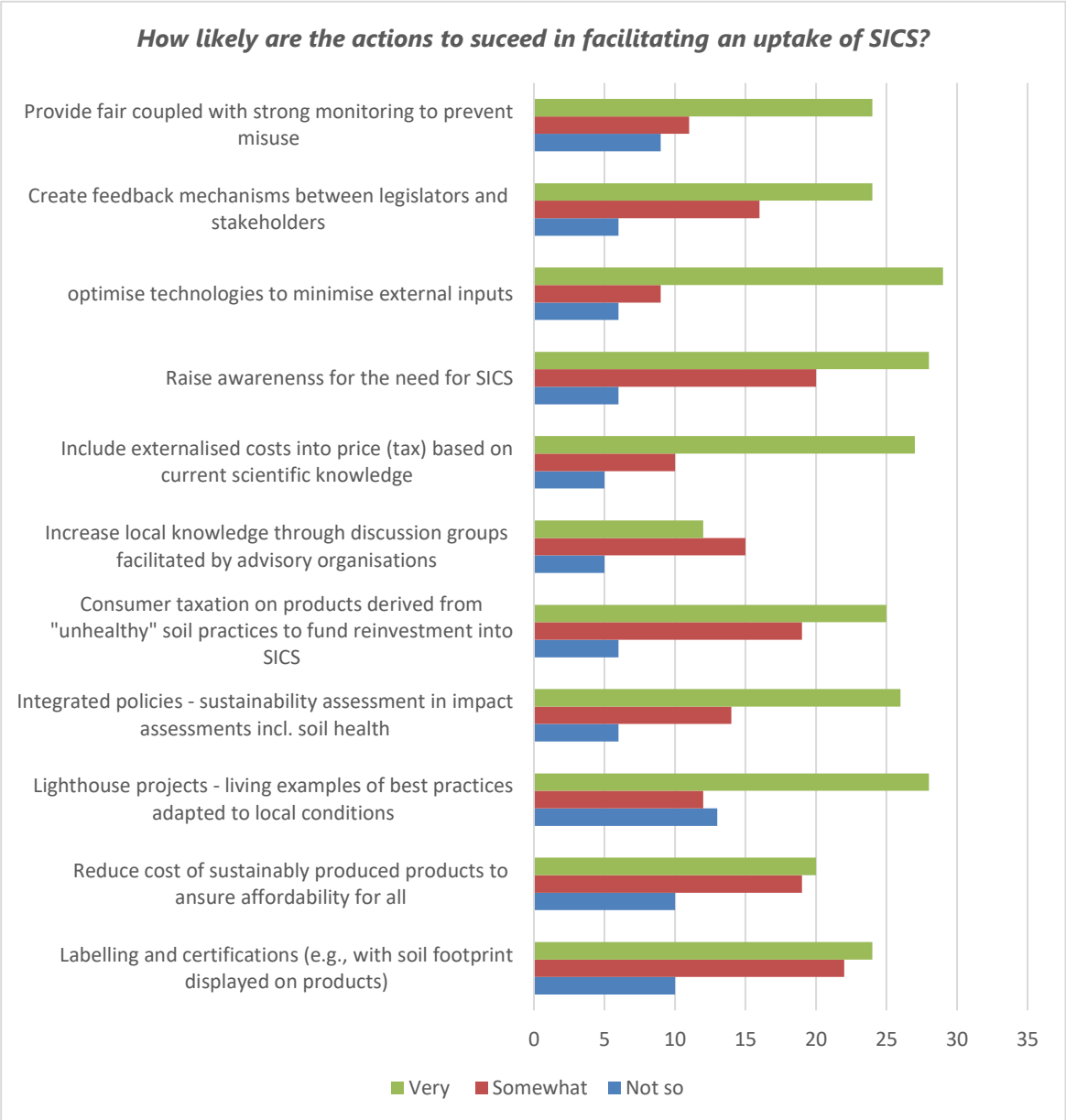
- Measures should be taken to educate consumers about the advantages and disadvantages of conventional farming practices vs. sustainable practices to ensure increased demand for sustainably produced products and encourage the retail sector to make these more widely available to all sections of society. Important points raised by the stakeholders include informational labelling schemes for products that are good for soil (informing customers how the product contributes to soil health or having a sustainability score). For such schemes, tracking and tracing of products can use available technologies already used for other purposes. Better promoting sustainable products would increase their market value and the customers' willingness to pay, leading to a fairer compensation for sustainable practices. This is especially important where costs of unsustainable production are not reflected in the consumer prices.
- An innovation award could be an effective instrument to create awareness for

sustainable producers and production methods amongst consumers and farmers alike. To this end, cooperatives or producer associations play a major role in marketing these products, explaining production methods – especially important for practices such as sewage sludge application which might be perceived as a high-risk technique – and negotiating prices with retailers.

Box 2: Actions identified by EU stakeholders as most promising in facilitating a wider uptake of SICS

Priority actions identified by EU stakeholders

During an EU-level workshop, stakeholders were asked to identify the most important actions to overcome key barriers to the wider uptake of SICS. The graph below details the eleven actions stakeholders defined and how they assessed their likelihood of facilitating the uptake of Soil Improving Cropping Systems?



Annex I: Guidance and input for Study Site Teams: Participatory workshop on adoption

V5 – February 2019

Drafted by Melanie Muro and Zuzana Lukacova (Milieu, WP7 Leader) with contributions from other WP and Study Site Representatives.

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Introduction

Over the course of the first two years of the project, various work packages have investigated the question of how to facilitate the uptake of SICS from various perspectives. Our research so far has looked at the scientific literature, previous research projects and policy studies to understand how the following aspects play a role in the adoption of agricultural practices in general, and SICS in particular:

- Social factors, such as norms, trust and attitudes (WP 3);
- Policies, including EU-level, national and regional policies (WP 7);
- Advisory services (WP 8);
- Applicability of various SICS based on a range of climate, soil and land use factors (WP 6);
- Impact of SICS on profitability and sustainability (WP 2, 4, 5, 6).

We would now like to investigate the question of SICS adoption in the study sites to better understand what might promote or hinder the uptake of the SICS you are currently testing in your sites. On this basis, we would also like to identify actions for the national and (sub)regional level which have the potential of promoting SICS adoption. Please note that we use the very broad term "actions", as these might include various types of interventions and could range from new/adapted policies to educational initiatives.

Overall approach

As already discussed at the last plenary meeting in Billund (DK), we would like to propose a **participatory workshop** to discuss these issues.[52]

This document provides

1. Explanation of workshop objectives, duration, reporting and suggested participants

[52] This would correspond to "Stakeholder Workshop 2" in the list of stakeholder activities outlined in the Description of Action (page 11f.).

and format of the workshop;

2. A proposed structure for the workshop including a set of guiding questions, methods and activities;
3. Background material to support Study Site Teams[53] in facilitating the workshop (Annex).

We would like to highlight that this guidance outlines various options for organising the workshop. Study site teams may decide the extent to which they want to discuss suggested topics with their stakeholder groups and whether they want to focus on a specific set of SICS only or on the larger topic of soil quality, protection and agriculture.

Please note that this guidance and background material may need to be adapted to your specific situation and your goals for the adoption workshop. Please do contact Zuzana (zuzana.lukakova@milieu.be) and Melanie (melanie.muro@milieu.be) if you have any questions or need our support in tailoring the suggested approach to your needs.

Workshop objectives

The general aims of the workshop are twofold:

1. **To identify and describe key barriers/enablers** facilitating the adoption of SICS, and a change towards agricultural practices beneficial to soil in general, and
2. **To identify actions at national and/or (sub)regional level** which have the potential of promoting the desired change.

Workshops can focus specifically on the SICS being tested in the study site. Alternatively, study site researchers might choose to organise a more general workshop on the question of soil quality/protection. The specific objectives you define for your event will influence the type of stakeholders you invite to the discussion, as well as the duration and format of the event.

Outputs of the workshop will feed into a deliverable detailing action at various scales of governance which could promote the adoption of SICS. Findings may also be used for producing dissemination outputs targeted at different audiences.

Workshop participants

Ideally, a workshop addressing the questions of adoption will bring together various perspectives and interests ranging from a group of actors, including farmers, policy-makers and advisory services.

[53] We generally refer to Study Site Teams as there are usually a number of people working in each SoilCare study site.

Study site teams should consider whether stakeholder groups they are already working with (within the context of SoilCare or as part of their regular engagement activities) would be interested in the topic of adoption and whether it may be beneficial for the discussion to broaden the group of participants for the adoption workshop.

Workshop duration

We suggest allocating at least half a day to the discussion of adoption; this could form part of a one-day event or could be organised as a dedicated meeting.

Bringing stakeholders together and asking them to take time out of their busy schedule to take part in a workshop can be challenging. Consider combining the workshop with a field day. **Field days** are scheduled to take place as part of the work programme of WP5. The purpose of these field or demonstration days is for stakeholders to visit the SoilCare experiments, and to experience and discuss their results. Please discuss the option of combining the workshop with a field day with us so we can liaise with WP5.

Workshop structure

This guidance proposes to organise the workshop in three steps. Please remember to schedule breaks between the different activities where you feel they are needed. Participants will appreciate an opportunity to chat to each other over a coffee. Also, some activities might require a change in the set-up of the room or the preparation of material (e.g. to reorganize results from one step of the process for the next step; attach new work sheets to the walls etc).

Reporting the workshop discussions and outputs

After the workshop, please send us a brief report of the workshop containing:

- the agenda;
- list of participants;
- a brief summary of the main discussion points per SICS and process step outlined.

To make this reporting task as easy as possible for you, make sure that you work in a team of at least two people, with one person taking notes and the other person facilitating the discussion. We would also advise you to take photos of all material used to structure the discussion, such as flip charts or white boards as these can be submitted with the report. Throughout this guidance, we include example tables which you could use to structure your discussions and document results. Please use these tables or adapt them as needed to report

your results.

Proposed workshop structure/steps: Guidance for Study Site Teams

This section describes in detail the steps which we propose for the workshop.

Before you go through this process with your participants, please bear in mind that some stakeholders might be new to SoilCare or that the last meeting might have occurred a year ago. You might therefore need to reintroduce the project and, most importantly, the concept of SICS. To manage expectation, please also present the objectives of the adoption workshop, the expected outcomes and how results will be used in the project.

Please note that the aims of the adoption workshop are twofold: firstly, to identify key barriers/enablers facilitating the adoption of SICS, **and** the identification of actions which have the potential of promoting the desired change. **Study Site Teams should aim to work through all the steps of the outlined process in order to develop some feasible solutions to existing (and future) challenges to the uptake of SICS in their study site regions.**

Step 1: **Describe the SICS being tested in your study site, and the expected benefits/impacts of these specific SICS for your study site.**

- ➔ You can do this by compiling the information in a table (see example below) on a large piece of paper or a white board. Depending on the time available for the discussion, you may want to prefill as little or as much of the information as you want. The important point is that you review the SICS, its main characteristics and benefits together with the group of stakeholders present (see below for an example for a table structure). The point of this step is not to collect the participants' feedback on the benefits or costs of the SICS as there might be conflicting views when it comes to some of the details; they are, of course, invited to add their own perspectives. The objective here is to introduce everyone to the SICS tested in the sites as a basis for the subsequent discussion on ways of promoting their adoption.
- ➔ If needed, you can use Tables 1 and 2 (attached in the Annex) to help you prepare this step. These tables summarise the evidence available from the literature on costs, benefits etc. of the different SICS. Should you already have some first results from the field trials, these could be presented to kick off the discussion and even be accompanied by a field visit as described above.
- ➔ Please take a picture of the completed worksheet/board

Example for a table format to describe SICS tested in your site: Feel free to add those column headings that you and your stakeholder find relevant

SICS tested in site	Costs	Yield	Income	Environmental impacts (positive and negative)	…

Step 2: Identify and describe the main barriers and enablers to SICS adoption.

➔ To structure the discussion, we suggest you write down each SICS (described in the previous step) in the middle of a large sheet of paper or a board (see example below). Use one sheet of paper per SICS. You could start of the discussion by posing the following two simple questions:

- *To what extent are farmers adopting this SICS (or components of it)?*
- *What are barriers/incentives to its uptake?*

➔ Table 3 in the Annex lists areas where we expect barriers and enablers to be identified and lists more detailed questions per category which can be used by the facilitator as prompts should participants struggle to engage in the discussion.

To help you prepare this step, you could go back to your documents from the stakeholder workshop where you selected the SICS to be tested in your study site. The question of adoption probably played a role in your discussions with the stakeholders and there might be some points which you might want to revisit with the group.

Options for organising the discussion

- Ask participants to write down their ideas on sticky notes and discuss and organise them into the categories presented in Table 3 (Annex) collectively in a group.
- Alternatively, lead an open group discussion based around the seven categories and points presented in Table 3 (Annex). You could note down any enablers and barriers directly on the sheet of paper.
- Depending on the number of SICS being discussed and the size of the group, stakeholders could be divided into groups and rotate around the room to work on the different SICS in turns.

➔ Regardless of which approach you use, you could start with a blank page with only the

SICS in the middle or by organising the barriers/enablers categories as headings around the SICS.

WP6 will provide a series of eights maps reflecting important climate, soil and land use properties required for the SICS tested in your study site as well as an overall applicability map showing the combined effect (an overlay) of the eight maps. These can be used to reflect on the biophysical barriers and enablers facing the adoption of the SICS tested in your study site more widely. This could be used as an entry point for a broader discussion on barriers as participants might find it easier to start with the biophysical conditions.

Questions you could ask to discuss these layers are:

- Do you consider that the 8 individual maps and the final applicability map provide plausible information on the applicability of the action? If not, can you indicate which ones should be altered?
- Are there important bio-physical aspects – beyond the 8 currently taken into account – that you feel are missing? If so, which ones?
- Is there any regional / national data that you would be able to provide or are aware of that would improve the applicability assessment for your region or country substantially?

WP 6 will prepare a short note on the purpose and construction of the applicability layers to support Study Site Teams in this discussion.

➔ Please take a picture of the completed worksheet/board

➔ *Example format for structuring barriers and enablers for SICS adoption using a generic example: Write the SICS in the middle of a piece of paper or whiteboard. You will need one paper or board per SICS (if you are discussing all SICS tested in your study site). Then list all the enablers (opportunities) on the left side and all the barriers on the right side. The table shows a generic example of what different enablers and barriers could look like.*

Enablers		Barriers
Policy Positive incentives in national/EU policy	SICS selected	Economic Time/labour costs
Economic Availability of financial incentives		Knowledge Lack of knowledge of risks/farmers are unsure about risks
Biophysical conditions		Social/cultural factors

Favourable climate and soil conditions for application		Not well tested by farmers/unwillingness to try new options

Step 3: Identify and assess feasibility of actions to promote SICS adoption

- ➔ **A simple ranking exercise** where participants are asked to rank the factors listed on either side from least to most important could be used to develop a first understanding of relative importance. Use different coloured sticky dots and pens to ask participants to identify those barriers and enablers which are important now and those, which are most likely to change over the next 30 years. Each participant should be given 20 sticky dots (10 of each colour) and asked to identify the three most important factors affecting SICS adoption now and those, which are most likely to change over the next 30 years. They can distribute dots according to their preference, for example placing 10 dots on the most important barrier/enabler of splitting dots between several barriers/enablers. Alternatively, participants could be allowed to place up to 10 marks directly on the board if you want to use markers instead of pens. If you want to explore in more detail how some of these barriers and enablers might change over time, participants could be asked to place a post-it with their thoughts about the change next to the barrier or enabler they expect to change. The facilitator will then sum up the dots or marks to arrive at a ranking of current and future barriers and enablers.
- ➔ You can then discuss the highest ranked enablers and barriers and think about how these can be supported or overcome.
    - This could be a **group discussion** where the study site team asks stakeholders to identify actions which could remove some of the barriers identified and to promote SICS uptake in their study site region. Actions could address any type of factor and could be located at different scales of governance, i.e. local, regional or national.
    - Another option would be to work in **break-out groups** focusing on individual SICS. Groups could then rotate around the room, so that each stakeholder has an opportunity to work on all SICS. Alternatively, the different groups might discuss and validate their results with the whole group.
- ➔ Ask participants to think about **actions which could remove barriers or strengthen enablers.** Here you can again consider expected changes of these factors over time – how likely are they to change and what would be the impact?
- ➔ When you are identifying actions, stakeholders should also think about their effectiveness and the feasibility of this action. Please bear in mind that it might not be feasible to remove certain barriers (such as biophysical conditions) or that some actions might be completely unrealistic.
- ➔ Questions you might ask when identifying and evaluating feasibility/effectiveness of

actions to remove the identified barriers to adoption include:

- What is their effectiveness to promote adoption?
- Are there any obstacles to implementing a specific action?
- What are their implementation costs?
- Do they fit the economic situation?
- Do they fit the institutional context?
- What is, overall, their realistic potential for successful implementation?

➔ The table below suggests a format for organising and capturing the discussion.

➔ The material listed under Step 3 in the ANNEX provides some information on how social/cultural factors, knowledge and information and the policy environment may shape adoption. For each of these sets of factors, their impact on adoption plus a sub-set of questions is provided. You might want to transfer these tables or parts of these tables to large sheets of paper or provide the participants with hand-outs. Depending on the initial ranking, you may focus in more detail on one or all of these categories of factors. You may of course focus on any other area, such as economic or technical barriers/enablers.

➔ Please take a picture of the completed worksheet/board

Example format for identifying and evaluating actions for removing barriers and supporting enablers for SICS adoption

Feasibility of implementing action (rank from 1 = not feasible to 4 = very feasible)	**Effectiveness of action to promote adoption** (rank from 1 = little effective to 4 = highly effective)	**Actions to support enablers** Identify action and describe who could implement the action and how/when in your specific condition	**Enablers**	**SICS selected**	**Barriers**	**Actions to remove barriers** Identify action and describe who could implement the action and how/when in your specific condition	**Effectiveness of action to promote adoption** (rank from 1 = little effective to 4 = highly effective)	**Feasibility of implementing action** (rank from 1 = not feasible to 4 = very feasible)
4 (very feasible); easy to implement on existing experimental farm	3 (moderately effective); might not reach many farmers	Increase farmers' knowledge in benefits to soil. Demonstration sites run by advisory services.	**Social/cultural** Positively received by farmers		**Institutional/policy** Excessive administrative rules	Simplify rules/provide guidance	4 (highly effective)	2 (somewhat feasible); would require time and political will by agencies.
		Provide trainings/workshops on e.g. machinery used Who/how/when would implement this action?	**Technical** Some farmers possess required know-how		**Knowledge** Lack of knowledge of risks/farmers are unsure about risks	Advisory services/training		

ANNEX: MATERIALS

The materials presented here are organised by step outlined in the process guide above:

STEP 1: Description of SICS being tested in your study site, and expected benefits

The tables below are taken from the WP2 report A preselection of soil-improving cropping systems, Executive summary Work Package 2, Revised version 02-02-2017 (Table 1 can be found on page 34 and Tabe 2 on page 28.

Table 1: List of promising general SICS

Component	Expected impact
Crop rotation	Improves crop productivity, soil biodiversity and system sustainability; decreases need for pesticides and risk of erosion
Green manures, cover crops, catch crops	Improves SOM content, soil structure, soil biodiversity, nutrient use efficiency; decreases nutrient leaching, run-off, erosion
Integrated nutrient management	Improves crop productivity, soil nutrient status and resource use efficiency;
Enhanced efficiency irrigation	Improves crop productivity and resource use efficiency; minimizes risks of salinization and desertification
Controlled drainage	Improves crop productivity and resource use efficiency; minimizes the risk of waterlogging
Reduced tillage	Reduces energy cost and may enhance SOM content and soil structure; may increase the need for herbicides/ pesticides
Integrated pest management	Improves crop productivity and resource use efficiency; minimizes the loss of biodiversity.
Smart weed control	Improves crop productivity and resource use efficiency; may decrease the need for herbicides
Smart residue management	Reduces evaporation and soil temperature; may increase/decrease the succes of germination
Controlled trafficking	Reduces energy cost and the risk of soil compaction
Integrated landscape management	Improves biodiversty and cropping systems sustainability

Table 2: Preliminary assessment of components of SICS: productivity and sustainability indicators.

Components of SICS	Crop yield & quality	Soil quality	Farm income	Resource use efficiency	Environmental impacts
Monocultures (reference)	0	0	0	0	0
Crop rotation	+	+	+	+	+
Wide rotations (1:6)	+	+	+	++	++
Narrow rotations (1:3)	+/-	+/-	++	+/-	+/-
+ root crops (1:2)	++	-	++	+/-	-
+ legumes(1:3)	+	+	+	++	+
+ allelopathic plants (1:4)	-/+	+	-/+	+/-	0
+ cover crops(1:1)	+	+	-/+	+	+
+ intercropping	++	+	+/-	++	+
+ green manures (1:1)	++	++	+/-	+	+
+ phytoremediation	+/-	+	+/-	+/-	+
Fallow/set-aside (1:6)	--	+	--	--	-
No fertilization (reference)	0	0	0	0	0
Fertilization	+	+	++	+	--
Balanced fertilization	++	+	++	+	-
Precision (split) fertilization	++	+	++	+	-
Manure application	+	++	++	+	-
Compost application	+	++	++	+	-

Components of SICS	Crop yield & quality	Soil quality	Farm income	Resource use efficiency	Environmental impacts
Biofertilizers (micro-organisms)	+	+	+	-/+	-
Liming	+	++	+	+	+
No irrigation (reference)	0	0	0	0	0
Irrigation	++	+	++	+	-
Flood irrigation	+	+/-	+	+/-	--
Sprinkling irrigation	+	+	+	+/-	-
Drip irrigation	++	+	++	+	+/-
Fertigation	++	+	++	+	+/-
No drainage (reference)	0	0	0	0	0
Drainage	+	+	+	+	+/-
Tile drainage	+	+	+	+	+/-
Controlled drainage	+	+	+	+	+
No tillage (reference)	0	0	0	0	0
Conventional tillage	+	+/-	+/-	-	-
Reduced tillage	+	+	+/-	+/-	-/+
Deep ploughing	+/-	+	+/-	+/-	+/-
Subsoiling	+/-	+	+/-	+/-	+/-
No pest management (reference)	0	0	0	0	0
Chemical pest management	++	-	++	+	-
Biological control	++	0	++	+	0
No weed control (reference)	0	0	0	0	0
Conventional weed control	++	-	++	+	-
Mechanical weed control	++	-/+	+	-/+	-/+
No mulching (no reference)	0	0	0	0	0
Residue mulching	+	+	+	+	+
Plastic mulching	++	-/+	+	+	-/+
No controlled trafficking (reference)	0	0	0	0	0
Controlled trafficking	+	+	+/-	+	+
No landscape management (reference)	0	0	0	0	0
Landscape management	0	0	+	+/-	+
Hedges, riparian zones	0	0	+	+/-	+
Agroforestry	-/+	+/-	+/-	+	+
Crop – livestock integration	+	+	+	++	+
Terracing, contouring	+	+	+/-	+	+

STEP 2: Identification/description of the main barriers and enablers to SICS adoption.

Facilitators of and barriers for adoption can be broadly grouped into the following broad categories:

Table 3: Barriers and enablers for SICS adoption

Economic (farm/market) conditions	Market conditions might be favourable or not. Market coditions might include prices, supply chain arrangements and possible food assurance schemes/protocols, the role of private sector actors, consumer preferences and consumption patterns. New practices might not seem profitable or come with high investment and labour costs. • *What are the costs versus the benefits of using the SICS?* • *Are there costs preventing its uptake? Explain what the costs are (e.g. new machinery, more labour)?* • *Are there economic risks involved in using the SICS? Explain what the risks are (e.g. uncertain effect on yield/quality, volatile markets, loss of contract)?* • *Are there any economic incentives for adopting the SICS?*
Biophysical conditions	Climate and soils might be favourble or unfavorable. • What are the biophysical and crop type barriers stopping the adoption of the SICS?
Technical barriers	Techniques/practices might not be sufficiently tested yet or required acquisition of new skills/training. • *How difficult is the SICS? Are there agronomic/technical risks involved?* • *Does the SICS require extra skills, knowledge, education, training? For the advisors and/or for the farmers?*
Knowledge / information	Farmers may not be sufficiently informed about soil improving practices/cropping systems or the extent to which the technique/practice might be applicable to them. • *Are farmers aware of the SICS? Do they understand the potential benefits?* • *Is it easy to access the relevant information? Does it cost anything?* • *Can advisory/ extension services effectively support farmers with the adoption of SICS?* • *Can farmers visit demonstration sites, or do they have the opportunity to try it out on the farm?*
Social/cultural factors	Farmers are unwilling of testing new practices and techniques; limited promotion of SICS by farmer organisations. • *Do personal motivations and values prevent uptake by farmers?* • *Do cultural aspects (e.g. traditional ways of doing things, accepted behaviours, habitual attitudes) prevent uptake?* • *Are there supportive social networks, peer support if farmers want to learn about or uptake up the SICS?*
Institutional and policy environment	Policies (including regulation, economic, voluntary and information instruments) hinder the uptake of SICS by subsidising or promoting other practices.

STEP 3: Step 3: Identification/feasibility of actions to promote SICS adoption

The material presented below first provides some background information for workshop

facilitators highlighting the relationship between the different types of adoption factors and SICS uptake. This is followed by a set of questions for the specific set of adoption factors.

Social/cultural factors

As a highly social species, our actions are influenced by those around us, just as we influence those close to us like our friends and family. The networks that we are connected to affect how we and our society functions. For example, knowing the right kind of people can make it easier for someone to find a job, which benefits the individual. Equally, working together on a problem with trusted networks such as close friends can make the process more fruitful than working with strangers that you don't trust, which benefits the group.

The benefits that we as individuals and society receive as a result of social interactions is called "social capital" and this is thought to be made up of a number of factors.

- Trust: we work best with the people we trust, and not trusting someone can severely affect our relationship. Trusting the information someone gives can influence whether we decide to act on that information.
- Norms: norms are the commonly-held way in which we act in a society. For instance, there is a norm for Brits to make small-talk about the weather, just as there's a norm for them to queue.
- Connectedness: who we associate with affects us. If we only associate with people similar to ourselves, we tend not to pick up new skills and information as quickly than if we associate with people who are different to us.

Questions/Exercise
One important question could be to ask participants who they think are the most important sources of information (e.g. other farmers, advisory services, farming magazines, websites etc.) for farmers when farmers want to learn new things. This could be done as a group discussion with the whole group if there are fewer than 8 people, or in a few smaller groups of, say, 4-6 people if the group is larger. The discussion could start out by getting participants to talk about which these sources of information are and have the note taker list them on a flip chart. Then it would be useful to get them to rank them from most to least likely to act on the information they receive from each of these sources which would be a good indication of whether they trust that information and the source.

Knowledge/information

Advisers need access to evidence and tools from research to formulate credible and tailored advice for farmers (e.g. on nutrient and SOM management) particularly with respect to the co-benefits and trade-offs of different or combinations of soil management options under varying scenarios
Build technical capacity in advisory services this is key for soil management particularly in advisers' field assessment soil data and soil analysis interpretation skills in the context of nutrient management and soil health indicators
Improve **links between research institutions and advisory services** to encourage integration of scientific and practitioner soil knowledge as part of this capacity building Recognise the new facilitating role of advisers and provide **training in initiating fostering and brokering farmer-centred networks** interested in soil management
Build on and support **existing farmer networks** and **communities of practice where adviser researcher and farmer are already learning and experimenting together on** soil management
Raise adviser awareness about the value of soil and its multiple functions and threats to shift the focus away from meeting EU CAP regulatory requirements or single functions
Build capacity **in the farming community**. Supporting innovative experimental and peer to peer learning should be complemented with education and **awareness raising** about soil among all farmers particularly given the demand-led nature of many advisory services.

NB It is acknowledged that the terms **adviser, researcher and farmer** are simplistic and not always mutually exclusive they are used here as a 'short cut'

Questions/Exercise

Please note that there is not one definition of advisor/advisory services. WP8 colleagues use the following definition: advisory services can be defined as *sets of organisations that support and facilitate people engaged in agricultural production to solve problems and to obtain information, skills, and technologies, by enabling farmers to co-produce farm-level solutions by establishing service relationships with advisers.*

If knowledge/information is one of the key areas where participants identify barriers, there are two options for identifying actions for improving the situation: 1) present a summary of the key points in the table and ask stakeholders to identify the most relevant actions for your study site/country; or 2) start with a blank piece of paper and use the table as guidance for the facilitator.

The following questions can be used to guide the discussion:

1. ***What is** adviser's expertise for:*

- *soil physical assessment, soil data and soil analysis interpretation skills in the context of nutrient management and soil health indicators,*
- *recommending appropriate SICS?*
- *if poor how do we **build capacity in advisory services**? Can you give specific examples of effective training/upskilling?*

2. ***What is adviser awareness*** *about the value of soil? How can the focus be shifted away from meeting EU CAP regulatory requirements, or single functions towards SICS?*
3. ***Who*** *should we target for dissemination about SICS (who are the main influencers?) and what is the best way of sharing this information with them?*

Impacts of EU policies, instruments, and measures on SICS adoption[54]

	CAP			WFD				
Policies/instruments	**Greening**	**Cross-compliance**	**RDP**	**Nitrates Directive**	**Birds and Habitats Directives**	**Sewage Sludge Directive**	**Sustainable Use of Pesticides Directive**	**Fertilisers Directive**
SICS								
Green manures, cover crops, catch crops	Cover crops and catch crops are eligible measures under EFAs.	No directly relevant standards	Rural development measures can be used to cover transaction costs associated with cover crops i.e. seeds and increased use of machinery, targeted cover crops identified in SoilCare could be included in an agri-environmental-climate payment (Pillar 2).	No directly relevant standards. However voluntary codes of Good Agricultural Practice (GAP) include requirements for crop rotations, soil winter cover, and catch crops to prevent nitrate leaching and run-off during wet seasons.	No directly relevant standards	No directly relevant standards	Cover crops and catch crops are included under measures relating to integrated pest management and can be included in MS action plans for reducing pesticide use.	No directly relevant standards
Crop rotation	Although the *Crop Diversification* greening measure incentivizes increasing the number of crops in agricultural holdings, it does not specifically address crop rotations. The measure permanent	No directly relevant standards	Costs associated with crop rotation can potentially be covered by AECM.	No directly relevant standards. However voluntary GAP codes include requirements for crop rotations, soil winter cover, and catch crops to prevent nitrate leaching and run-off during wet seasons.	No directly relevant standards	No directly relevant standards	Crop rotation can be beneficial for pest management and are included under measures relating to integrated pest management and can be included in MS action plans for reducing pesticide use.	No directly relevant standards

[54] Not directly relevant for study sites in CH and NO.

	CAP			WFD				
Policies/instruments	**Greening**	**Cross-compliance**	**RDP**	**Nitrates Directive**	**Birds and Habitats Directives**	**Sewage Sludge Directive**	**Sustainable Use of Pesticides Directive**	**Fertilisers Directive**
	pasture can potentially limit long crop rotations by limiting the possibility to plough up pasture that has been established for > 5 years.							
Integrated nutrient management	No directly relevant standards	Cross-compliance with the Statutory Management Requirements (SMR) on Nitrates Directives directly impacts on farmers management of nutrients.	RDP measures can be used to finance manure storage, small scale bio refineries to reduce GHG/Ammonia emissions, and information and awareness building relating to nutrient management and nutrient runoff/leaching	Directly impact on farmers nutrient management by establishing maximum levels of nitrogen applied, periods and landscapes where application of nitrogen based fertilsers is inappropriate, designation of Nitrate Vulnerable Zones (NVZ) and GAPs relating to reducing nitrogen runoff such as cover, catch crops, and buffer strips.	HD Annex II species may require more stringent conditions to reach favourable conservation status than the ones necessary to achieve good ecological status including nutrient levels.	Sewage sludge is a cost-efficient source nutrient. SSD sets limits for land-based applications and establishes maximum levels of pollutants in sewage sludge (although most MS have stricter standards compared to SSD).	No directly relevant standards	Does not directly affect nutrient management but provides stable operating environment for trade in fertilisers. The new fertilisers directive is expected to make organic fertilisers and products that improve uptake of nutrients more readily accessible for farmers.
Enhanced efficiency irrigation	No directly relevant standards	No directly relevant standards	RDP measures relating to physical investments can be	No directly relevant standards, but have indirect	No directly relevant standards	No directly relevant standards	Annex III includes use of balanced fertilisation, liming	No directly relevant standards

	CAP			WFD				
Policies/instruments	**Greening**	**Cross-compliance**	**RDP**	**Nitrates Directive**	**Birds and Habitats Directives**	**Sewage Sludge Directive**	**Sustainable Use of Pesticides Directive**	**Fertilisers Directive**
			used for investments in more efficient irrigation systems and/or drainage systems.	impacts relating to ensuring sufficient quality and quantity of water.			and irrigation/drainage practices in general list of practices for Integrated Pest Management.	
Controlled drainage	No directly relevant standards	No directly relevant standards	RDP measures relating to physical investments can be used for investments in more efficient irrigation systems and/or drainage systems.					
Reduced tillage	No directly relevant standards	No directly relevant standards for reduced tillage, but would satisfy GAECs for improving soil organic matter and reducing soil erosion	RDP investment measure can be used to cover costs associated with specific machinery required for zero tillage or low tillage practices.	No directly relevant standards, but technique reduces need for application of nitrogen-based fertilisers and could be used as strategy for reduction of nitrogen leaching especially in designated NZVs.	No directly relevant standards, but reduced tillage systems can be beneficial for farmland bird population and habitats.	No directly relevant standards	Annex III includes use conservation agriculture i.e. reduced tillage in list of general practices for Integrated Pest Management.	No directly relevant standards
Integrated pest management	No directly relevant standards, although several measures that qualify as EFAs could also be part of integrated pest	No directly relevant standards	No directly relevant standards	No directly relevant standards		No directly relevant standards	Integrated Pest Management is one of the key features of the regulation and stresses that Member States shall establish	No directly relevant standards

	CAP			WFD				
Policies/instruments	**Greening**	**Cross-compliance**	**RDP**	**Nitrates Directive**	**Birds and Habitats Directives**	**Sewage Sludge Directive**	**Sustainable Use of Pesticides Directive**	**Fertilisers Directive**
	management strategies						or support the establishment of necessary conditions for the implementation of integrated pest management	
Smart weed control	No directly relevant standards	No directly relevant standards	No directly relevant standards	No directly relevant standards	No directly relevant standards	No directly relevant standards	Integrated Pest Management includes different measure to control weeds and reduce the use of herbicides	No directly relevant standards
Smart residue management	No directly relevant standards	Cross-compliance includes GAECs on improving soil organic matter and a ban on burning of stubble, but does not include measures per se on residue management	No directly relevant standards	No directly relevant standards	No directly relevant standards	No directly relevant standards	No directly relevant standards	No directly relevant standards, although residue management is part of the broader principles of Integrated pest management described in annex III of the directive

Impacts of national and regional policy instruments and measures on SICS adoption: Overview of key policies, Loddington (UK)[55]

Policy name	Scale	EU or MS level	Impact on SICS	Description of policy
CAP GAEC Cross-compliance Standards	National	EU	Plant cover; Agroforestry; Nutrient management; Tillage management; Machine & traffic management; Mulching	'Cross compliance' is a set of rules which farmers and land managers must follow on their holding if they are claiming rural payments. The cross compliance is set in the Common Agriculture Policy Regulations 2014 and further explained in the Guide to cross compliance in England 2017. Schedule 2 of the Common Agriculture Policy Regulations 2014 requires restoration of a footpath or bridleway after ploughing and prohibits crop and specified vegetation burning (section 2). The Schedule further requires the farmers to cover the soil with crops or other vegetation, although exceptions are allowed (section 3); maintain green cover, prevent erosion and refrain from applying fertilisers or pesticides to land near watercourses and hedgerow, although exemptions are allowed (sections 4 and 5).
The Guide to Cross-compliance in England 2017	Regional	EU	Plant cover; Agroforestry; Nutrient management; Tillage management; Machine & traffic management; Mulching	The Guide contains the 'Good Agricultural and Environmental Conditions' (GAECs) which cover, inter alia, environment, climate change and good agricultural condition of land. GAEC 4 establishes that farmers must take all reasonable steps to protect soil by having a minimum soil cover all year around unless there is an agronomic justification for not doing so, or where establishing a cover would conflict with requirements under GAEC 5 that causes soil erosion. GAEC 5 requires measures to be put into place to limit soil and bankside erosion (cropping practices and structures, vehicles, trailers and machinery). GAEC 6 prohibits farmers from burning cereal straw or cereal stubble or certain crop residues, with the aim of maintain the level of organic matter in soil.
CAP Rural Development Programme 2014 - 2020	National	EU	Intercropping, crop rotations	The Rural Development Programme (RDP) for England was formally adopted by the European Commission in 2015. It outlines England's priorities for using the €4 billion available from 2014-2020 (national and EU contributions). The main objective of the RDP is better management of natural resources and the wider adoption of farming practices which are climate friendly. Soil degradation has been estimated to cost the economy £0.9-1.4bn per year in England and Wales (p. 108). Soil erosion and acidification and climate change have been recognised as an important issue in England (p. 37 - 39). To tackle these issues, RDP's Focus area 4C focuses on preventing soil erosion and improving soil management. One of the measures concerns crop diversification (p. 396); buffer strips on cultivated land (p. 397); winter cover crops (p. 398); etc.
Countryside Stewardship	Regional	EU	Plant cover, Landscape Management, Integrated Management.	Countryside Stewardship (CS) provides financial incentives for land managers to look after their environment through activities such as: conserving and restoring wildlife habitats; flood risk management; woodland creation and management; reducing widespread water pollution from agriculture; keeping the character of the countryside; preserving features important to the history of the rural landscape and encouraging educational access.

[55] Each guidance was adapted to the specific study site country.

Policy name	Scale	EU or MS level	Impact on SICS	Description of policy
				The scheme is open to all eligible farmers, woodland owners, foresters and other land managers in England and is suitable for many types of land use (for example conventional and organic farmland, coastal areas, uplands and woodlands). It is a competitive scheme with application scored against local priority targets to maximise environmental benefit.
Pesticides Control legislation	national	EU	Pest management	The Control of Pesticides Regulations (1986, as amended in 1997) provides a high-level regulatory setting with details of pesticides subject to control and a system of approvals required for supply, storage and use. In addition, the Plant Protection Products (Sustainable Use) Regulations 2012 transpose Directive on sustainable use of pesticides. Users of plant protection products/pesticides are required to take all reasonable precautions to protect, inter alia, soil.
Campaign for the Farmed Environment	Regional	MS	Integrated management, Pest Management, Landscape, Plant cover & Nutrient Management	The Campaign for the Farmed Environment (CFE) is an industry-led initiative encouraging voluntary management that will benefit the environment, whilst ensuring efficient and profitable food production. CFE guidance includes voluntary measures and best practice actions to benefit wildlife and to protect natural resources on farmland, and promoting resource use efficiency is a natural progression for CFE. It is a partnership of 15 farming and Environmental Organisations working together.

Questions/Exercise

1. *Do you think that SICS tested in your site fit in with existing policies and instruments?*
2. *Do existing policies place requirements or incentives on farmers which would hamper/promote SICS uptake? What factors would need to change to ensure effectiveness of existing policies in terms of SICS adoption?*
3. *Do you think that we need to change existing policies/ instruments and how?*

Annex II: Summaries of country reports

This annex presents a compilation of the executive summaries of all country reports. Some of these reports were updated after the compilation of this deliverables. The full updated reports can be downloaded at https://www.soilcare-project.eu/resources/resources-for-policy-makers.

Flanders, Belgium

The main soil threats in Flanders include low soil organic carbon content, nutrient leaching, acidification, erosion, and soil compaction related to use of heavy machinery and deep ploughing. It has been reported that increasingly more input is needed to keep the plough layer in optimal state. However, an indiscriminate increase in inputs is neither economically nor environmentally sustainable. SICS that are being tested at the study site are thought to address these soil threats and include integrated cover crops, nutrient managements (Organic soil amendments in wheat fields, reduced tillage, and cover crops) and reduced tillage (Soil cultivation and soil cover in maize as well as testing of novel soil-improving crops in demonstration fields, respectively) and therefore represent important opportunities that could be targeted for this region. This section takes the policies identified in the previous section and evaluates how they can mitigate the soil threats in Flanders.

Policy shortcomings and opportunities for facilitating the uptake of SICS in Flanders, BE

SICS adoption is already promoted through a range of existing regulatory, economic, and voluntary policy instruments and measures in the Flemish part of Belgium (shaded in light green). The analysis shows that that several policies address the SICS that were tested in the study site (shaded in dark green): cover crops and reduced tillage are incentivised under the CAP's cross-compliance standards and the greening measures, respectively. Cover crops are also widely promoted by the CVBB. Integrated nutrient management is to a great extent regulated by the Nitrates Directive and the Manure Decree, but also influenced by greening requirements under the CAP which incentivises the use of nitrogen-fixing crops and crops with lower fertilization demands.

Table 1: Coverage of SICS in current regional policies, instruments, and measures in Flanders, BE

Policy	Crop rotation	Green manures, cover crops, catch	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
Regional policies											
CAP GAEC Cross-compliance Standards (Randvoorwaarden: Norm voor een goede landbouw- en milieuconditie van grond (GLMC))											
CAP Greening Payment Requirements (Vergroeningspremie: vergroening in het kader van het Gemeenschappelijk Landbouwbeleid)											
CAP Agro-environmental measures (Agromilieumaatregelen)											
Management Agreements (Flemish Land Agency) (Beheerovereenkomsten (VLM))											
CAP RDP (Programma voor Plattelandsontwikkeling (derde)											
Decree on Integrated Water Management (Decreet betreffende het integraal waterbeleid)											
Manure Decree - Action Programme for the Implementation of the Nitrate Directive 5th Manure Action Plan (Mestdecreet - Actieprogramma ter uitvoering van de Nitraatrichtlijn 2015-2018 (het 5de Mestactieplan))											
National Action Plan (NAPAN - National Actie Plan d'Action National)											
Decree on the Sustainable Use of Pesticides and Associated Decisions (Decreet duurzaam gebruik van pesticiden en de bijhorende besluiten)											
Decision of the Flemish Government on Erosion Control (Besluit van de Vlaamse Regering betreffende de erosiebestrijding)											

Evidence gathered through desk research, interviews and a stakeholder workshop show that different factors contribute to and undermine the uptake of SICS in general, and of the practices tested in Flanders, Belgium, in particular. These include:

- "Fitness" and complexity of policies
- Limited coherence of policies
- Lack of financial incentives
- Timeframe of policies:
- Limited soil education/knowledge dissemination

The table below provides an overview of barriers and enablers for the SICS tested at the study site and which were identified by stakeholders during the adoption workshop.

Table 2: Adoption barriers, enablers, and actions to increase uptake of the SICS tested at study site identified by stakeholders: *Due to time limitations, some of the workshops only addressed a subset of SICS tested in the respective study site. Participants were asked to identify actions for the most important factors affecting SICS adoption; therefore, not all adoption factors were discussed in detail. To assess the effectiveness and feasibility of an action, a scale from 1 (not at all effective/feasible) to 4 (highly effective/feasible) was used.*

Integrated nutrient management: Organic soil amendments in wheat fields ("Wood chips")			
Adoption factors (+ or -)	**Actions**	**Effectiveness**	**Feasibility**
Sufficient supply of woodchips (-)	Small scale initiatives and local collaboration to increase supply	--	--
Cooperative purchase of machinery (+)	*None identified*	--	--
Awareness and knowledge of advantages (+)	*None identified*	--	--
Possibility of management agreements (VLM) (+)	*None identified*	--	--
Costs of implementation (-)	Increase supply: plantation of hedges on public areas Identification of areas with the highest added value Recycling applications (first as litter)	2 4 4	2 2/3 2
Inconsistencies in the legislation (-)	Adapt legislation OVAM Certificates (analysis and origin) Include other crops (hemp, bamboo, elephant grass),	4 2 --	3-4 3 2
Insufficient knowledge about the advantages (-)	Demonstrations, research, professional press, Mapping of fields with greatest need	4 4	4 2
Reduced tillage: Soil cultivation and soil cover in maize ("Grass undersowing")			
Adoption factors (+ or -)	**Actions**	**Effectiveness**	**Feasibility**
Erosion prevention (+)	Reimbursement as anti-erosion measure	--	--
Prevention of soil compaction (+)	*None identified*	--	--

Lower yield in some conditions (-)	Crop rotation Mapping the fields where strip till is feasible	1-2 1	Depends on farm/crop management 4
Increased need for pesticides (-)	Choice of cover crop Preserving residual herbicides Precision spraying	2 1 --	1 3 --
Need for new machinery (-)	Learn other techniques (non-inversion tillage), provide incentives for strip till technique e.g. through the Flemish Agricultural Investment Fund	4	3

Recommendations for actions to promote the uptake of SICS

Based on this analysis, and feedback collected from stakeholder, the following recommendations are formulated. Whilst the actions outlined here specifically aim to promote the uptake of the practices tested at the Flemish study site, they are likely to encourage the adoption of soil-improving cropping systems in general.

- ***Increase policy coherence and adapt current legislation:*** Most policies affecting soil quality in Flanders are regulatory instruments, and there is evidence that these can be improved. Highly complex legislation and a lack of policy coherence mean that the existing regulations do not inspire adoption. In addition, regulation in Flanders is seen as being punishing rather than rewarding, which is an additional barrier to adoption. There is also evidence to suggest that having general regulations (rather than soil-specific regulations) have a limited impact – the Sustainable Use of Pesticides Directive has affected the types of pesticides available but has done little to improve the soil quality.
- ***Introduce better designed economic incentives to counter costs associated with SICS:*** Economic instruments are primarily to be found in the CAP. There is, however, potential to develop economic instruments further in Flanders, as one of the key barriers to adoption are the costs – whether they are direct costs (such as investing in new machinery) or opportunities costs (such as foregoing revenue from potatoes or biomass).
- ***Better explore ways of encouraging voluntary practices:*** There was little evidence of wide-spread grass-roots volunteer mechanisms (such as farmers' cooperatives), however, it is clear that certain voluntary measures, such as reducing tillage, are already being implemented. While our research was not able to confirm that these practices were adopted because of a specific voluntary measure, it does show that farmers in Flanders are willing to adopt voluntary measures, and perhaps more can be done to encourage them.
- ***Support awareness raising and dissemination of good practices:*** The role of education and knowledge dissemination cannot be underestimated. In the Flanders

case study, it was noted in several instances that farmers were adopting SICS or other beneficial practices only to "pass a test" or gain a subsidy. This means that the adoption of SICS is very precarious – if the subsidy was to be discontinued or a specific monitoring requirement changed, farmers would likely revert back to old practices. Similarly, when adoption practices do not go as planned and are subsequently deemed a failure, the causes need to be systematically investigated and documented to shape future initiatives. Similarly, successes need to be disseminated as good practice. By investing in education and knowledge dissemination, the adoption (and retention) of SICS becomes much more sustainable. In Flanders, there are organisations, such as the B3W (Advisory Service to improve Soil and Water Quality) which was only established in January 2021. This service is supervised by the Flemish Land Agency and includes all practical research stations in Flanders, the Soil Service of Belgium and the Flanders Research Institute for Agriculture, Fisheries and Food. This service will focus each year on a limited number of topics linked to soil and water quality. It offers three services: individual coaching, focus groups and thematic exchange events. This study did not uncover any evidence of conflicting messages or over-information, however, in general, care should be taken to ensure farmers are met with a consistent message, based on scientific evidence, which is presented without being overwhelming and confusing.

Prague - Ruzyne, Czech Republic

The main soil threats in region where the study site Prague - Ruzyne, Czech Republic is located include soil compaction, loss and limited input of soil organic matter (SOM), deterioration of soil structure, and erosion. Soil-improving Cropping Systems (SICS) that are being tested within the context of the SoilCare project include application of manure; use of catch crops and growing of legumes and are thought to alleviate the soil threats identified above. In addition, several long-term experiments (LTE) with various tillage methods (conventional, reduced and no tillage), as well as different fertiliser applications and organic farming methods are being carried out in the study site. Crop rotation systems are also used, which include the use of legumes and other soil improving crops. By-products (post-harvest residues) are left on the fields to recover nutrients and organic matter. The methods trialed through the SoilCare and LTE therefore present important practices that might benefit soil health in the region if widely taken up.

Policy shortcomings and opportunities

The table below provides an overview of policies promoting the full range of SICS covered by the SoilCare project (shaded in light green) and the SICS (including the LTE) tested at the study site (shaded in dark green). The analysis shows that all of the identified policies regulate and incentivse the SICS trialed to some degree. The use of crop rotation, green manure, and

reduced tillage practices are incentivised through CAP GAEC Cross-compliance Standards, greening payments and are further specified by the national Anti-Water Erosion Measures Guidance. CAP cross-compliance establishes nutrient management requirements for farmers receiving direct payments. In addition, water policies place limitations on fertiliser use in certain areas.

Table 1: SICS addressed by key policies, Prague-Ruzyne (CZ)

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
CAP GAEC Cross-compliance Standards	■		■			■					
CAP Greening payments requirements 1st Pillar, EFAs	■	■									
Cross-compliance, PŘÍRUČKA OCHRANY PROTI VODNÍ EROZI *(Anti-Water Erosion Measures Guidance)*	■	■				■			■		
Předpis č. 156/1998 Sb. , Zákon o hnojivech, pomocných půdních látkách, pomocných rostlinných přípravcích a substrátech a o agrochemickém zkoušení zemědělských půd (zákon o hnojivech), ve znění pozdějších předpisů *(Act on Fertilisers Use)*			■								
Zákon 254/2001 Sb., o vodách a o změně některých zákonů (vodní zákon), ve znění pozdějších předpisů *(Water Act)*	■		■								
Předpis č. 262/2012 Sb., Nařízení vlády o stanovení zranitelných oblastí a akčním programu, novelizováno nařízením vlády č. 277/2020 Sb. *(Ordinance Concerning the Establishment of Vulnerable Zones and Action Plan)*	■		■								
Zákon 223/2015 Sb., kterým se mění zákon č. 185/2001 Sb., o odpadech a o změně některých dalších zákonů, ve znění pozdějších předpisů *(Waste Act)*			■								

Research and stakeholder interviews indicate that there are several factors that shape the success or failure of policy instruments in the study site region, and the uptake of SICS tested in the sites in general. These factors include:

- The Regulatory framework is perceived as complex and excessive by farmers
- Weak/incorrect enforcement of policy measures

- Cost of modern machinery for soil-improving cultivation methods
- Existing non-governmental bodies have the potential of facilitating change

Recommendations for actions to promote the uptake of SICS

Based on this analysis, and feedback collected from stakeholders, this report presents actions for the national and/or (sub)regional level with the potential of promoting the uptake of SICS. Drawing on these insights, the following general recommendations can be made:

- **Review, if needed adapt and effectively communicate policy requirements:** Highly complex legislation and possibly a lack of policy coherence mean that the existing regulations do not inspire adoption. In addition, compliance with regulation in the study site region is seen as being burdensome rather than rewarding, which is an additional barrier to adoption. Farmers struggle to interpret and comply with rules.
- **Offer regular training and information services to keep farmers informed about new developments and insights:** dissemination of knowledge, awareness raising, and education are important components of policy interventions and they should be used in parallel with economic and legislative instruments. Regular training, informative sessions on latest innovations are preferred to one off training sessions which have limited impact.
- **Engage with farmers and trusted organisations to deliver advise and training:** peer to peer learning and bottom-up initiatives are powerful tools to deliver knowledge to farmers as they play a great degree of trust in their fellow producers. Partnering with farmers willing to pioneer new techniques or trusted organisations, such as the Czech Agrarian Chamber, will ensure that target audiences are reached, and new information is heard.
- **Improve policy monitoring and enforcement:** while it was found that there are a number of policies already in place that – directly and indirectly - regulate and incentivise different SICS, stakeholders report that outcomes on soil health are limited due to weak enforcement mechanisms. It is clear mechanisms for checking compliance with existing regulations need to be strengthened and expanded. Regulatory instruments need to be monitored and effective sanctions put in place for non-compliance in order to be successful in prompting adoption. This needs to include the training of farm inspectors who, like farmers, need to understand the regulatory requirements and their practical implementation.
- **Subsidise transition to sustainable practices**: the uptake of certain SICS, such as reduced tillage, might require upfront investments, such as the purchasing of additional seeds and new machinery. Grants should be made available to farmers buying new

equipment to implement these practices or groups of farmers intending to set up a 'machinery exchange'. Such an exchange could also be set up and managed by the regional/local farm advisory services or municipalities.

Thurgau, Switzerland

The main soil threats in Switzerland include low organic carbon content and compaction. SICS that are being tested at the study site are thought to address these soil threats and include compaction alleviation measures (Controlled traffic management on grass verges), integrated nutrient management (Under-foot fertilisation after CULTAN procedure) as well as green manure in combination with minimum tillage (Green manuring and minimum tillage applied between crop rotations). They therefore represent important practices that might benefit soil health in the region if widely taken up.

Policy shortcomings and opportunities

The table below provides an overview of policies promoting the full range of SICS covered by the SoilCare project (shaded in light green). Several policies, including Federal Act on the Protection of the Environment, the Soil Damage Ordinance , and the Federal Act on Agriculture contain provisions which allow the cantons to define measures to prevent soil erosion and a deterioration of soil fertility, and which might include different SICS. Compliance with these measures is often linked to financial support paid out to farmers (under the Direct Payment Ordinance) and can also involve penalties if agricultural practices result in soil, losses (under the Soil Damage Ordinance). Compaction alleviation measures, the use of cover crops, reduced tillage, and green manure, the SICS tested at the study site (shaded in dark green), are regulated, and incentivised to some extent: there are no dedicated policies regulating or incentivsing controlled traffic management methods to reduce compaction other than through the pieces of legislation mentioned above. The use of crop rotation is promoted by the main national and cantonal agricultural policies, specifically the Soil Damage Ordinance which mentions crop rotations as a possible practice to protect the fertility of soil and reduce the loss of organic content. The Direct Payment Ordonnance has the potential to promote crop rotation by providing financial incentives to adopt the practice (Article 16 Controlled crop rotation and Article 17 Suitable soil protection). Green manure is not explicitly mentioned but the crop rotation requirements above can potentially to lead to cover crops being used as green manure. In addition, the Ordinance stipulates that nutrient circuits should be closed as far as possible. No excess phosphorus and nitrogen are to be applied which might indirectly promote the use of green manure. Similarly, reduced tillage practices do not seem to be explicitly incentivised or regulated by any of the policies analysed. However, they might be considered as soil protection measures to prevent erosion in line with Article 17 and could therefore be eligible for financial support.

Table 1: Coverage of SICS in current national and regional policies, instruments and measures in Thurgau, CH

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
National policies											
Bundesgesetz über den Umweltschutz (Federal Act on the Protection of the Environment)											
Gewässerschutzverordnung (Ordinance on Protection of Waterbodies)											
Verordnung ueber die Belastungen des Bodens (Soil Damage Ordinance)											
Bundesgesetz ueber die Landwirtschaft (Federal Act on Agriculture)											
Direktzahlungsverordnung (Direct Payment Ordinance)											
Chemikaliengesetz (Federal Chemicals Act)											
Chemikalien-Risikoreduktions-Verordnung (Chemical Risk Reduction Ordinance)											
Pflanzenschutzmittelverordnung (Ordinance on Plant Protectants)											
Duenger-Verordnung (Fertilizer Ordinance)											
Regional policies											
Landwirtschaftsgesetz (Act on Agriculture)											
Verordnung über die Strukturverbesserungen in der Landwirtschaft (Ordinance on structural improvements in agriculture)											

Recommendations for actions to promote the uptake of SICS

Research indicates that there are several factors that shape the success or failure of policy instruments in Thurgau, Switzerland, and the uptake of SICS tested in the study site region in general. These factors include:

- Lack of policies incentivising development or use of more efficient machinery
- Costs of SICS adoption
- Weak monitoring and enforcement

- Lack of knowledge and effective dissemination
- Insufficient/biased information available
- Market pressures favour short-term priorities over long-term investment in soil health
- Reluctance to change due to perceived peer pressure and closed farming community
- Self-perception as "food suppliers"

Table 2: SICS being tested, adoption factors (enablers or barriers) and actions to overcome the barriers: Due to time limitations, some of the workshops only addressed a subset of SICS tested in the respective study site. Participants were asked to identify actions for the most important factors affecting SICS adoption; therefore, not all adoption factors were discussed in detail. To assess the effectiveness and feasibility of an action, a scale from 1 (not at all effective/feasible) to 4 (highly effective/feasible) was used

Compaction alleviation: Green verges			
Adoption factors (+ or -)	**Actions**	**Effectiveness**	**Feasibility**
More yield with less effort, incl. manuring input (+)	Information dissemination/spreading awareness e.g., through the creation of lighthouse farms or innovation awards	**3**	**4**
Improved soil activity (less compaction) (+)	*None identified*	--	--
Green strips (always passable) (+)	Information and field inspections	2	4
Lack of knowledge transfer (-)	Field demonstrations (+) Farm advice (canton)	3	4
Effort/practicability (-)	*None identified*	--	--
Takes time for effects to be visible (-)	Technical aids to visualise changes	4	4
GPS required (1x per sowing), width of parcel, material quality (e.g., light machines) (-)	*None identified*	--	--
Implementing new ideas needs interest and time of the farmer, willingness to take risks (-)	Risk coverage	2	2
D2 system does not fit yet, e.g., flower strips in favour of a functional biodiversity (-)	Practical suitability	3	3
Fertilisation/amendments: Fertilisation with Controlled Uptake of Long-Term Ammonium Nutrition (CULTAN)			
Adoption factors (+ or -)	**Actions**	**Effectiveness**	**Feasibility**
Long term pricing (+)	*None identified*	--	--
Homogeneous and raw soils, flat roots, legumes (+)	*None identified*	--	--
Precise fertilisation, chrome steel (+)	*None identified*	--	--
Extraction of ammonia from sewage treatment plants will reduce the prices (+)	CULTAN manuring as part of climate strategy -> WIN-WIN situation on local, regional and global level	4	4
Side-line business, livestock-free, specialisation, innovative ideas (+)	*None identified*	--	--
Increase humus content in soils (+)	*None identified*	--	--
Very expensive, price must be lower at every level, corrosion, and logistics (-)	Lower prices on all levels -> Ecosystem services must be weighted differently / valued differently	3	4
Stony soils, compacted soils, dry soils, taproot (-)	*None identified*	--	--
Yeast concentration, working width, material quality, need specialist for the injection (-)	*None identified*	--	--
Common doctrine, dominance of the fertilizer industry. Need of more promotion, publications (-)	*None identified*	--	--

Structural opinion, added value on farms (-)	*None identified*	--	--
Principles of Agricultural Crop Fertilisation in Switzerland (PRIF), organic suitability (-)	Intermediate step: disclosure of research, intensify dissemination of results and research, then: adapt guidelines accordingly - the benefits should be considered at long term and over large chain (including ecosystem services).	4	4
Sulphur content (-)	*None identified*	--	--

Recommendations for actions to promote the uptake of SICS

Based on this analysis, and feedback collected from stakeholder, the following recommendations were formulated:

- **Consider introducing weight limitations for agricultural machinery into legislation:** for road vehicles, legislation establishes limitations on maximum weight. This is lacking for agricultural machines and should be integrated in existing agricultural legislation or a new, dedicated technical standard. In addition, farm advisory services need to include information on lighter vehicles farmers may use in the services they offer.
- **Facilitate the extraction of ammonia from sewage treatment plants:** the cost of applying the CULTAN procedure could be reduced if ammonia extracted from sewage treatment plans could be made available to farmers. This might require the investment in research on different methods for ammonia recovery by public institutions, a dissemination of findings and technologies and a subsequent adaptation of current guidelines on "Principles of Agricultural Crop Fertilisation in Switzerland" (PRIF).
- **Establish better monitoring and enforcement mechanisms:** while it was found that there are several policies already in place that – directly and indirectly - regulate and incentivse different SICS, stakeholders report that outcomes on soil health are limited due to weak implementation and enforcement mechanisms. It is clear mechanisms for checking compliance with existing regulations need to be strengthened and expanded. Performance indicators and measurements need to be clearly specified and monitored.
- **Make soil health a stronger component of vocational training and continued education of farmers:** the move from conventional practices to SICS and sustainable agricultural practices requires a shift in attitudes as well as knowledge. Soil, as the main medium on which food and feed are grown, should feature highly on the curriculum for farmer training, be it basic vocational or continued adult learning. Farmers also need to be shown how to observe and measure soil changes – using simple methods and instruments - to make the benefits of SICS adoption visible in the short-term (where possible).

- **Reward environmental benefits generated by SICS and talk about it:** market forces need to be counterweight with subsidies rewarding the environmental benefits generated through the SICS to make their uptake more appealing to farmers. It will be equally important to continue to educate consumers about the advantages and disadvantages of conventional farming practices vs. sustainable practices to ensure increased demand for sustainably produced products and encourage the retail sector to make these more widely available to all sections of society. An innovation award could be an effective instrument to create awareness for sustainable producers and production methods amongst consumers and farmers alike.
- **Provide balanced information and establish opportunities for peer-to-peer learning:** personal conviction of farmers to adapt new practices is a powerful tool in the face of multi-layered challenges. Education plays a very important role in that regard. Therefore, unbiased knowledge and information- must be made accessible to farmers. This information should not favour any particular interest. Some of the practices benefitting soil will require farmers to learn about these techniques, their application to different conditions as well as their benefits to change their misconceptions about these methods. Since farmers tend to place a lot of trust in their peers, establishing a network of lighthouse farms demonstrating how to use and adapt different SICS in the region would effectively support farmers in learning and sharing experiences about these practices.

Viborg, Denmark

The main soil threats in Viborg include loss of organic matter, soil compaction, erosion, severe nutrient losses (N and P) to the environment (especially from livestock farms). SICS that are being tested at the study site are thought to address these soil threats and include the introduction of soil improving crops (CROPSYS crop rotations, screening of different types of catch crops), soil cultivation measures (Different soil tillage intensities), and fertilisation/soil amendments (Different levels of fertilisation and liming). They therefore present important practices that might benefit soil health in the region if widely taken up.

Policy shortcomings and opportunities

The table below provides an overview of policies promoting the full range of SICS covered by the SoilCare project (shaded in light green). The analysis shows that several policies regulate and incentivse the use of *crop rotation,* cover crops, reduced tillage, and integrated nutrient: CAP cross-compliance standards, greening requirements as well as RDP measures incentivise the uptake of crop rotations/crop sequencing, reduced tillage methods, and to a lesser extent, cover crops. However, provision included in the Act on Agricultural Use of Fertilisers and on Plant Cover has the potential to increase the adoption of cover crops. Nutrient input from

agriculture is regulated through several pieces of water legislation, mostly with a view to protecting water quality rather than soil. Policies such as the Act on Agricultural Use of Fertilisers and on Plant Cover define limitation for fertiliser use in certain areas, mandate the establishment of buffer strips, and establish rules for the use of plant cover/catch crops.

Figure 1: SICS addressed by key policies, Viborg (DK)

Policy name	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
Bekendtgørelse om krydsoverensstemmelseBEK (CAP GAEC cross compliance standards)	■		■			■					■
CAP Greening requirements	■	■				■					■
Det danske landdistriktsprogram 2014-2020 (Rural Development Programme 2014-2020)	■					■	■				■
Bekendtgørelse af lov om jordbrugets anvendelse af gødning og om plantedække (Act on Agricultural Use of Fertilizers and on Plant Cover)		■	■								
Aftale om fødevare- og landbrugspakken 2015 (Agreement on Food and Agriculture Package 2015)	■		■								■
Bekendtgørelse af lov om afgift af bekæmpelsesmidler (Act on Tax on Pesticides)							■				
Bekendtgørelse af lov om drift af landbrugsjorder (Act on Management of Agricultural Land)							■				■
Husdyrgødningsbekendtgørelsen (The Livestock Manure Order)			■								

Research and stakeholder interviews indicate that there are several factors that shape the success or failure of policy instruments in the study site region, and the uptake of SICS tested in the sites in general. These factors include:

- Costs of transitioning to new cropping systems
- Prioritisation of short-term financial benefits
- Lack of policy coherence
- Reluctance to abandon traditional practices
- Lack of continued learning and integration of emerging knowledge in practices

Recommendations for actions to promote the uptake of SICS

Based on this analysis, and feedback collected from stakeholders, this report presents actions for the national and/or (sub)regional level with the potential of promoting the uptake of SICS. Drawing on these insights, the following general recommendations can be made:

- **Subsidise transition to practices benefitting soil health:** the cost of transition to more sustainable practices is identified as an important barrier for the farmers. Forced to choose between short term and long-term gains, farmers often have no real motivation to forego their immediate revenues. The uptake of certain SICS, such as reduced tillage or cover crops might require upfront investments, such as the purchasing of additional seeds and new machinery. Grants should be made available to farmers buying new equipment to implement these practices or groups of farmers intending to set up a 'machinery exchange'. Such an exchange could also be set up and managed by the regional/local farm advisory services or municipalities.
- **Increase policy coherence:** policy conflicts and synergies need to be carefully analysed and aligned, in order not to discourage the transition to sustainable farming practices. Ultimately, this might require a prioritisation of certain objectives and targets (and operationalised by the right policy interventions) as a certain level of conflict is unavoidable to ensure the right balance between environmental, social, and economic sustainability. On a practical level, it is important for farmers to have clear, unambiguous information on the legal conditions they need to comply with – especially if they are tied to subsidies - and those that may be rewarded.
- **Offer regular training and information services to keep farmers informed about new developments and insights:** dissemination of knowledge, awareness raising, and education are important components of policy interventions and they should be used in parallel with economic and legislative instruments. Regular training, informative sessions on latest innovations are preferred to one off training sessions which have limited impact. Some of the practices benefitting soil will require farmers to learn about these techniques, their application to different conditions as well as their benefits to change their misconceptions about these methods. To this end, research findings should be made accessible and widely disseminated and educational activities should be encouraged. Knowledge should be disseminated via multiple channels, through the provision of guidance document but also farms visits and demonstration days. Workshops, encouraging peer to peer learning, and long-term experiments that will show the benefits of SICS are promising initiatives that can be supported.

Brittany, France

In the study site area in Brittany, France, soil-improving practices such as biological pest management, green manure, and organic fertilisers are methods already applied by farmers. The Soil-Improving Cropping Systems (SICS) tested by the SoilCare project include the use of different cover crops (oats versus mixed cover crops, interseeding cover crops in maize) and soil cultivation measures to shift or eliminate tillage (early sowing of wheat, direct sowing of maize in cover crop). The trialed practices aim to address the main soil threats found in the area, compaction, weeds, and low soil fertility and therefore represent important practices that might benefit soil health in the region if widely taken up.

Policy shortcomings and opportunities

The table below provides an overview of policies promoting the full range of SICS covered by the SoilCare project (shaded in light green). The analysis shows that several policies regulate and incentivse the use of cover crops and reduced tillage, including the CAP GAEC standards, and the CAP Greening Payment Requirements. In addition, environmental and water policies establish cover crop and tillage management requirements for certain areas.

Table 1: Coverage of SICS in current regional policies, instruments and measures in Brittany, France

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
CAP GAEC Cross-compliance Standards											
CAP Greening payments											
Rural development programme for Brittany											
Law for the Future of Agriculture, Food and Forests											
Investment supports for farms											
Environmental Code											
Rural and Marine Fishing Code											
Law on Water and Aquatic Environments											
Nitrates Regulation											
Plan Ecophyto II											

Evidence gathered through interviews, desk research and a stakeholder workshop shows that different contextual factors contribute to and undermine the uptake of SICS in general, and of the practices tested in the study site in particular. Some of the findings suggest that the uptake

of SICSs is improving. On the other hand, barriers to the uptake of these practices remain.

The key factors shaping the success of policy instruments include:

- Environmental conditions
- Lack of solidarity between farmers
- Changing policy objectives
- Top-down approaches to policy design and implementation
- Lack of a dedicated soil policy
- Insufficient policy enforcement and impact monitoring
- High transition costs
- Lack of targeted incentives
- Need for education and training
- Experimentation with and impact analysis of new instruments or policy tools at a local or sub-regional scale before adoption

The table below provides an overview of barriers and enablers for the SICS tested at the study site and which were identified by stakeholders during the adoption workshop. Participants were asked to identify actions for the most important factors affecting SICS adoption; therefore, not all adoption factors were discussed in detail. To assess the effectiveness and feasibility of an action, a scale from 1 (not at all effective/feasible) to 4 (highly effective/feasible) was suggested but not applied during the meeting due to time constraints.

Table 2: SICS being tested, adoption factors (enablers or barriers) and actions to overcome the barriers/support enablers identified by stakeholders

Adoption factors (+ or -)	Actions
Lack of coherence between policies (-)	More specific focus on soil health in policy
Top-down policy design (-)	Incorporating grass-roots movements into the implementation of policies, policies that can be tailored to specific circumstances
Costs of new practices in the short and long-tern (-)	Better use of financial support mechanisms (for instance subsidies for specific crops) to counter the negative impacts on farmers, especially in the short-term.
Environmental conditions, e.g., soil type (-) or (+)	*None identified*
Lack of awareness and education among farmers (-)	Encourage peer to peer learning and training

Recommendations for actions to promote the uptake of SICS

Based on this analysis, and feedback collected from stakeholder, the following recommendations were formulated:

- **Consider the development of a dedicated soil policy:** despite the existence of policies incentivising and regulating the use of SICS in Brittany, their focus is not

specifically soil related. While it is clear, both from the interviews and looking at the issues reported by grass-root organisations, that farmers are aware of soil threats in the region, the instruments in place may potentially reward behaviour which, while not detrimental to the environment, cannot be considered soil-improving. The development of a dedicated soil policy should therefore be considered. Such an intervention should be designed to accommodate farm diversity, featuring a robust monitoring and enforcement system.

- **Revise the existing policy framework to include long-term targets:** different priorities put forward by policies over time can create undesirable effects which are sometimes hard to remedy. An example from the region is the focus modernisation of farming in the last decades which led to practices that are today considered unsustainable. Policy design should incorporate the longer-term benefits and integrate a more holistic approach so that elements like soil which necessitate longer cycles can also be considered.
- **Provide tailored support to farmers transitioning to sustainable practices:** financial instruments should allow long-term change in practices rather than finance one off interventions. They should be designed in a way that offers integral solutions to farmers, for instance they should cover costs associated with machinery or other investments associated with change, which are important barriers for farmers.
- **Introduce more targeted financial incentives:** incentives should be more targeted and tied to specific actions to result in the desired change. For example, a subsidy could be tied to the use of a specific crop rather than a target such as "reduce the amount of maize grown" as it is currently done by the RDP for Brittany.
- **Offer regular training and information services to keep farmers informed about new developments and insights:** dissemination of knowledge, awareness raising, and education are important components of policy interventions and they should be used in parallel with economic and legislative instruments. Regular training, informative sessions on latest innovations are preferred to one off training sessions which have limited impact.
- **Engage with farmers and trusted organisations to deliver advise and training:** peer to peer learning and bottom-up initiatives are powerful tools to deliver knowledge to farmers as they play a great degree of trust in their fellow producers. There are examples of successful voluntary initiatives that are considered very effective in changing convictions and practices. Among those, farmers' groups are especially important. Such groups have a greater success of convincing farmers to adopt SICS for several reasons and can help demonstrate how to adapt practices and targets to specific geographic or other constraints, which may make SICS adoption more

attractive to farmers in the region. These voluntary initiatives can be supported by direct education to provide a better understanding of the benefits of SICSs to farmers, especially targeting the older generation of farmers.

- **Involve farmers in policy-design and implementation:** to ensure compliance with policy instruments, design appropriate measures, and foster innovation, farmers not only need to be better informed about policy instruments but should also be involved in their design and implementation, to the extent possible. This will be especially crucial for the national and regional implementation of EU policies, most importantly the post-2020 CAP which will give greater flexibility to Member States when designing their Strategic Plans.

Tachenhausen, Baden-Württemberg, Germany

The main soil threats in the study site in the German state of Baden-Württemberg include soil erosion, nitrate pollution and soil fauna at risk. SICS that are being tested at the study site and which are thought to address these soil threats include cover crops in combination with reduced/no tillage and glyphosate free management of conservation agriculture. They therefore represent important practices that might benefit soil health in the region if widely taken up.

Policy shortcomings and opportunities

The table below provides an overview of policies promoting the full range of SICS covered by the SoilCare project (shaded in light green). The analysis shows that several policies regulate and incentivse the use of cover crops and reduced tillage, the SICS tested at the study site (shaded in dark green): direct payments, greening measures, and rural development plans under the CAP all provide financial rewards to farmers adopting reduced or no-tillage practices. In addition, several national pieces of legislation, such as the Erosion Protection Ordinance establish tillage management requirements for certain areas. Many of these policies also incentivse the use of cover crops by farmers.

Table 1: Coverage of SICS in existing national and regional policies, instruments and measures in the German state of Baden-Württemberg

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
National policies											
Organic Farming Act (*Ökolandbaugesetz)*											
Düngegesetz (DüG) and Düngeverordnung (DüV) *(Fertiliser Act and Ordinance on good fertilising practices)*											
Nationaler Aktionsplan zur nachhaltigen Anwendung von Pflanzenschutzmitteln *(National Action Plan on the Sustainable Use of Pesticides)*											
Pflanzenschutzgesetz *(Plant Protection Act)*											
Sewage Sludge Ordinance *(Klärschlammverordnung)*											
Regional policies											
Massnahmen- und Entwicklungsplan Laendlicher Raum Baden-Wuerttemberg (BW) 2014-2020 *(Rural Development Programme for Baden-Wuerttemberg 2014-2020)*											
Verordnung zur Umsetzung der Gemeinsamen Agrarpolitik 2014 – 2020 *(Ordinance on the Implementation of the Common Agricultural Policy 2014-2010)*											
Act on Nature Protection, Landscape Management and Recreation Baden-Württemberg *(Landesnaturschutzgesetz Baden-Württemberg)*											
Water Act Baden-Württemberg *(Wassergesetz für Baden-Württemberg)*											
Teilbearbeitungsgebiet 41 - Neckar unterhalb Starzel oberhalb Fils, Bearbeitungsgebiet Neckar,FGE Rhein, Baden-Wuerttemberg *(Management plan sub-catchment 41 - Neckar below Starzel and above Fils (RBD Rhine, Neckar catchment, Baden-Wuerttemberg)*											
Förderprogramm für Agrarumwelt, Klimaschutz und Tierwohl (FAKT) *(Funding Program for Agronomic Environment, Climate Protection and Animal Welfare)*											
Verwaltungsvorschrift zur Förderung landwirtschaftlicher Betriebe in Berggebieten und in bestimmten benachteiligten Gebieten *(Compensation for agriculture in disadvantaged location)*											
Verordnung über Schutzbestimmungen und die Gewährung von Ausgleichsleistungen in Wasser- und Quellenschutzgebieten (SchALVO) *(Ordinance on safeguards and compensation in water and spring protection zones)*											
Landesbodenschutzgesetz *(Soil Protection Act Baden-*											

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
Wuerttemberg)											
Erosionsschutzverordnung Baden-Württemberg *(Erosion Protection Ordinance Baden-Wuerttemberg)*											

Evidence gathered through interviews, desk research and a stakeholder workshop shows that different contextual factors contribute to and undermine the uptake of SICS in general, and of the practices tested in the study site in particular. Some of the findings suggest that the uptake of SICSs is improving. On the other hand, barriers to the uptake of these practices remain.

The key factors shaping the success of policy instruments include:

- Lack of adequate financial incentive
- Influence of and information sharing within farmer communities and networks
- Strength and consistency of the regulatory framework

The table below provides an overview of barriers and enablers for the SICS tested at the study site and which were identified by stakeholders during the adoption workshop.

Table 2: Adoption barriers, enablers, and actions to increase uptake of the SICS tested at study site identified by stakeholders: Due to time limitations, some of the workshops only addressed a subset of SICS tested in the respective study site. Participants were asked to identify actions for the most important factors affecting SICS adoption; therefore, not all adoption factors were discussed in detail. To assess the effectiveness and feasibility of an action, a scale from 1 (not at all effective/feasible) to 4 (highly effective/feasible) was used.

Cover crops			
Adoption factors (+ or -)	**Actions**	**Effectiveness**	**Feasibility**
Reduced need for fertilisers (+)	*None identified*	--	--
Insufficient knowledge of farmers a problem	Establishment of network of model farms that demonstrate regional adaptation of SICS	4	4
	Dissemination of practice examples from research	2	4
Biodiversity enhancement; sustainable technique (+)	Highlighting of ecological aspects through effective dissemination of research results	4	2
Cost for seeds (-)	Reward environmental benefits through subsidies	4	2
Crop rotation management is complicated e.g., establishment	Integrate soil protection more strongly into vocational training 4	3	4
	Use network of model farms (see above)	4	4

and timing of tillage must be precisely matched (-)			
Reduced/no tillage			
Adoption factors (+ or -)	**Actions**	**Effectiveness**	**Feasibility**
Reduced fuel consumption, reduced workload (+)	Promote benefit to farmer's work-life-balance	--	--
Heavy soils can be cultivated (+)	*None identified*	--	--
Decreased erosion (+)	Reward environmental benefits achieved through direct seeding (e.g., reduced run-off), option to increase prices for sustainably produced products	4	2
Societal demand for sustainable products (+)	Educate society to appreciate the social value of climate, soil, and water body conservation (as a precondition for willingness to pay higher process)	3	1
Field demonstrations (+)	Establish network of model farms (see above)	4	4
	Effective dissemination of practice examples from research	2	4
Possibly lower yields, increased need for pesticides/new machines (-)	Establish mechanism for machine exchange	4	4
	Provision of grants	4	2
Crop rotation management is complicated (-)	Use network of model farms to share experiences	4	4
Application of practice on stony soils (-)	Facilitate exchange of experiences through network of model farms (see above)	4	4
"It looks wild"; pest management not possible without chemical plant protection (-)	Fund research on direct seeding vs no glyphosate	--	--
Impact of market forces, particularly on glyphosate debate	Limiting the influence of lobby groups on policymaking	4	2
Promotion of organic farming with derogations from the ploughing ban (-)	Provision of financial measures to counter economic pressure from the world market	4	1
	Reward environmental benefits achieved through direct seeding (reduced run-off, sustainable agriculture),	4	3
	Effective dissemination of practice examples from research	4	3

Recommendations for actions to promote the uptake of SICS

Based on this analysis, and feedback collected from stakeholder, the following recommendations were formulated:

- **Establish mechanisms for information sharing between farmers:** Some of the practices benefitting soil will require farmers to learn about these techniques, their application to different conditions as well as their benefits. Since farmers tend to place a lot of trust in their peers, establishing a network of model farms demonstrating how to use and adapt different SICS in the region would effectively support farmers in learning and sharing experiences about these practices.
- **Subsidise transition to practices benefitting soil health:** The uptake of certain SICS might require upfront investments, such as the purchasing of new machinery. Grants should be made available to farmers buying new equipment to implement these practices or groups of farmers intending to set up a 'machinery exchange'. Such an

exchange could also be set up and managed by the regional/local farm advisory services or municipalities.

- **Make soil health a stronger component of vocational training and continued education of farmers:** The move from conventional practices to SICS and sustainable agricultural practices requires a shift in attitudes as well as knowledge. Soil, as the main medium on which food and feed are grown, should feature highly on the curriculum for framer training, be it basic vocational or continued adult learning.
- **Reward environmental benefits generated by SICS and talk about it:** market forces need to be counterweight with subsidies rewarding the environmental benefits generated through the SICS to make their uptake more appealing to farmers. It will be equally important to continue to educate consumers about the advantages and disadvantages of conventional farming practices vs. sustainable practices to ensure increased demand for sustainably produced products and encourage the retail sector to make these more widely available to all sections of society.
- **Design more cohesive policies and effective enforcement mechanisms:** policies have great potential to shape practices, especially for large-scale farms. However, in order to achieve real impact, their implementation needs to be monitored more effectively and consistently. Furthermore, an improved synergy between different policies are considered important factors for future success.

Crete, Greece

The main soil threats in Greece include the imminent threat of desertification, characterised by loss of vegetation, water erosion, and subsequently loss of soil (erosion). SICS that are being tested at the study site are thought to address these soil threats and include the introduction of soil-improving crops (Conversion from orange orchard to avocado; cover corps in organic vineyards) as well as different soil cultivation measures (No till and conventional tilling in organic and conventional olive orchards). They therefore represent important practices that might benefit soil health in the region if widely taken up.

Policy shortcomings and opportunities

The table below provides an overview of policies promoting the full range of SICS covered by the SoilCare project (shaded in light green). The analysis shows that several policies regulate and incentivse the use of cover crops, and reduced tillage, the SICS tested at the study site (shaded in dark green): direct payments, greening measures, and rural development plans under the CAP all provide financial rewards to farmers adopting reduced or no-tillage practices and cover crops (in the form of nitrogen-fixing crops) but only on certain types of land. In addition, policies implementing the EU Organic Regulation formulate requirements for tillage

practices. The Nitrates Directive and the National Action Plan for Combating Desertification promotes the tested practices by explicitly referencing them as good agricultural practices to be adopted in specific areas. None of the policies identified as relevant do regulate or incentivise the uptake of soil-improving crops.

Table 1: Coverage of SICS in current regional policies, instruments, and measures in Greece

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
CAP GAEC Cross-compliance Standards (Πρότυπα για την καλή γεωργική και περιβαλλοντική κατάσταση (ΚΓΠΚ)		■		▒		■			▒		
CAP Greening Payment Requirements (Απαιτήσεις πληρωμής για οικολογικό προσανατολισμό/ "πρασίνισμα")	▒	■									▒
CAP Rural Development Programme 2014 – 2020 (ΠΡΟΓΡΑΜΜΑ ΑΓΡΟΤΙΚΗΣ ΑΝΑΠΤΥΞΗΣ ΤΗΣ ΕΛΛΑΔΑΣ)	▒	■		▒		■					
Regulation on organic production and labelling of organic products (Κανονισμός για τη βιολογική παραγωγή και την επισήμανση των βιολογικών προϊόντων και την κατάργηση του κανονισμού (ΕΟΚ) αριθ. 2092/91)	▒		▒			■	▒				
Protection of waters against pollution caused by nitrates from agricultural sources (Οδηγία για την προστασία των υδάτων από την νιτρορρύπανση γεωργικής προέλευσης)	▒	■	▒			■					▒
Pesticides Control Legislation (Καθορισμός πλαισίου κοινοτικής δράσης νε σκοπό την επίτευξη ορθολογικής χρήσης των γεωργικών φαρμάκων)							▒				
Fertiliser regulation (Κανονισμός σχετικά με τα λιπάσματα)			▒								
National Action Plan for Combating Desertification (Εθνικό Σχέδιο Δράσης κατά της ερημοποίησης)	▒	■		▒		■					

Recommendations for actions to promote the uptake of SICS

Research indicates that there are several factors that shape the success or failure of policy instruments in Crete, and the uptake of SICS tested in the study site region in general. These factors include:

- Weak policy coherence
- Ineffective implementation and enforcement of existing policies
- Higher costs of SICS implementation/transition costs
- Availability of conditional payments
- Reluctance to abandon traditional practices in favor of new methods
- Need for better information sharing and training opportunities

Table 2: SICS being tested, adoption factors (enablers or barriers) and actions to overcome the barriers: Due to time limitations, some of the workshops only addressed a subset of SICS tested in the respective study site. Participants were asked to identify actions for the most important factors affecting SICS adoption; therefore, not all adoption factors were discussed in detail. To assess the effectiveness and feasibility of an action, a scale from 1 (not at all effective/feasible) to 4 (highly effective/feasible) was used but not consistently applied in all stakeholder workshops.

Soil-improving crops: Conversion from orange orchards to avocados	
Adoption factors (+ or -)	**Actions**
Favourable climate (+)	*n/a*
High cost of implementation associated with purchase of avocado trees (-)	*None identified*
Policy set-up, lack of incentives (-)	*None identified*
Insufficient knowledge about new/alternative crop varieties and methods (-)	Provide guidance to farmers and advisory services to develop knowhow
Soil-improving crops: Cover crops organic vineyards	
Adoption factors (+ or -)	**Actions**
Resistance to change (mentality of farmers) (-)	Increase the skill level of Farm Advisory Services
	Demonstrate the benefits of SICS through workshops, exchange of practices, working with large-scale farmers as influencers of change, encourage peer to peer learning
Lack of awareness about the long-term benefits (-)	Demonstrate long-term benefits, supported by experiments, encourage peer to peer learning
Soil cultivation: Tillage/no tillage in olive orchards	
Adoption factors (+ or -)	**Actions**
Geomorphological conditions (steep slopes, stones, and rocks (-)	*n/a*
Lack of awareness and insufficient knowlegde (-)	Training, demonstration sites, peer-to-peer learning and better information dissemination

Recommendations for actions to promote the uptake of SICS

Based on this analysis, and feedback collected from stakeholder, the following recommendations were formulated:

- **Increase policy coherence:** policy conflicts and synergies need to be carefully analysed and aligned, in order not to discourage the transition to sustainable farming practices. Ultimately, this might require a prioritisation of certain objectives and targets (and operationalised by the right policy interventions) as a certain level of conflict is unavoidable to ensure the right balance between environmental, social, and economic sustainability. On a practical level, it is important for farmers to have clear, unambiguous information on the legal conditions they need to comply with – especially if they are tied to subsidies - and those that may be rewarded.

- **Strengthen policy enforcement:** While it was found that there are several policies already in place that – directly and indirectly - regulate and incentivse different SICS, stakeholders report that outcomes on soil health are limited due to weak implementation and enforcement mechanisms. It is clear mechanisms for checking compliance with existing regulations need to be strengthened and expanded. With the post-2020 CAP, new funding rules funding rules will be introduced. The Good Agricultural Environmental Conditions (GAECs) now offer a greater chance for soil protection. New conditions with the potential to improve soil health have been added, e.g., the new GAEC 7 requires "No bare soil in most sensitive period(s)". Cover crops will be an important strategy for meeting this requirement. The payment agencies should seek to ensure that these conditions are complied with and verified through, e.g., more frequent inspections and farmer reporting (including for example images of the implemented practices).

- **Subsidise transition to practices benefitting soil health:** The uptake of certain SICS, such as cover cropping, and reduced tillage, might require upfront investments, such as the purchasing of additional seeds and new machinery. Grants should be made available to farmers buying new equipment to implement these practices or groups of farmers intending to set up a 'machinery exchange'. Such an exchange could also be set up and managed by the regional/local farm advisory services or municipalities.

- **Introduce more targeted financial incentives:** incentives should be more targeted and tied to specific actions to result in the desired change. For example, a subsidy could be tied to the use of a specific crop or crop change.

- **Establish mechanisms for effective knowledge dissemination and exchange between farmers:** Some of the practices benefitting soil will require farmers to learn about these techniques, their application to different conditions as well as their benefits to change their misconceptions about these methods. To this end, research findings

should be made accessible and widely disseminated and educational activities should be encouraged. Knowledge should be disseminated via multiple channels, through the provision of guidance document but also farms visits and demonstration days. Workshops, encouraging peer to peer learning, and long-term experiments that will show the benefits of SICS are promising initiatives that can be supported.

- **Invest in and build capacity of Farm Advisory Services:** like framers, farm advisors also need to learn about new practices, their practical application, costs, and benefits to support farmers they assist. Strengthening the technical skills of farm advisory services and setting up mechanisms for continuous learning are therefore crucial.

Almeria, Spain

The soil-improving cropping systems (SICS) tested at the SoilCare study site in Almeria, Spain, include cover crops, reduced tillage, and efficient irrigation management. In addition, there are several long-term experiments testing various tillage methods (conventional, reduced and no tillage), fertiliser applications, crop rotation systems (including legumes and other soil improving crops), as well as residue management methods (post-harvest residues left on the fields for nutrients and organic matter recovery). Both the SICS trialled at the site within the context of SoilCare as well as the long-term experiments are aimed to address the main soil threats of soil compaction, water scarcity, hight salt content, and excessive nutrient input. They therefore represent important practices that might benefit soil health in the region if widely taken up.

Policy shortcomings and opportunities

The table below provides an overview of policies promoting the full range of SICS covered by the SoilCare project (shaded in light green). The analysis shows that several policies regulate and incentivse the use of cover crops, reduced tillage, and integrated nutrient management, the SICS tested at the study site (shaded in dark green): direct payments, greening measures, and rural development plans under the CAP all provide financial rewards to farmers adopting reduced or no-tillage practices and cover crops (in the form of nitrogen-fixing crops) but only on certain types of land. Integrated nutrient management practices are regulated mostly through water protection legislation. In addition, policies implementing the EU Organic Regulation formulate mandatory requirements for fertiliser use and tillage practices. Most of the policies identified as relevant do not regulate or incentivise efficient irrigation practices with the exception pf the National Action Programme to Combat Desertification, which, however, mainly focuses on promoting good soil management practices through information sharing and demonstration projects.

Table 1: Coverage of SICS in current regional policies, instruments and measures in Almeria (ES)

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic	Integrated landscape management
CAP GAEC cross-compliance standards and greening payments[56]											
CAP Greening requirements **Error! Bookmark not defined.**											
CAP Rural Development Program of Andalucía 2014-2020											
Royal Decree on agro-ecolocical production and its indication in agricultural products and foodstuffs											
Decree on organic agro-food production in Andalusia											
III Andalusian Plan of Ecological Production Horizon 2020	X	X	X			X	X			X	X
Law on fiscal, administrative and social measures											
Law on Waters for Andalusia.											
Royal Decree amending Annex II of Royal Decree 1514/2009 of 2 October, which regulates the protection of groundwater											
Royal Decree protecting waters from the pollution by nitrates derived of agricultural sources											
Order approving the action program applicable in areas vulnerable to nitrate pollution from designated agricultural sources in Andalusia											
Decree on the Use of Sewage Sludge in the Agricultural Sector											
Decree approving the Waste Regulations of Andalusia											
Royal Decree establishing the framework of action to achieve a sustainable use of phytosanitary products											
Decree on the prevention and control of pests, the sustainable use of plant protection products, the inspection of equipment for its application and the creation of a census of equipment for the application of phytosanitary products											

[56] Real Decreto 1075/2014, de 19 de diciembre), sobre la aplicación a partir de 2015 de los pagos directos a la agricultura y a la ganadería y otros regímenes de ayuda, así como sobre la gestión y control de los pagos directos y de los pagos al desarrollo rural

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic	Integrated landscape management
Royal Decree modyifying the Royal Decree 506/2013, of June 28, on fertilizer products											
National Action Programme to Combat Desertification											

Recommendations for actions to promote the uptake of SICS

Research indicates that there are several factors that shape the success or failure of policy instruments in Almeria, and the uptake of SICS tested in the study site region in general. These factors include:

- Applying for payments is too bureaucratic
- Lack of enforcement
- Trust in long-established practices
- Costs of transitioning to new practices
- Environmental conditions

The table below provides an overview of barriers and enablers for the SICS tested at the study site and which were identified by stakeholders during the adoption workshop.

Table 2: Adoption barriers, enablers, and actions to increase uptake of the SICS tested at study site identified by stakeholders. Due to time limitations, some of the workshops only addressed a subset of SICS tested in the respective study site. Participants were asked to identify actions for the most important factors affecting SICS adoption; therefore, not all adoption factors were discussed in detail. To assess the effectiveness and feasibility of an action, a scale from 1 (not at all effective/feasible) to 4 (highly effective/feasible) was used.

Cover crops and enhanced efficiency irrigation: Controlled deficit irrigation and mulch cover with pruning remains and vegetable coverings sown	
Adoption factors (+ or -)	**Actions**
Maladapted policy setup (-)	More focus on subsidising sustainable agricultural management
Farmers' resistance for new practices (-)	Dissemination of successful experience from fellow farmers
Lack of awareness and information (-)	Awareness and information campaigns, training of farmers
Lack of access to technology and machinery (-)	Financial support through grants or subsidies

Lack of enforcement and monitoring (-)	Effective control of current regulations regarding bad practices (burning of stubble, illegal wells, pollution by nitrates)
Water scarcity (-)	*None identified*
Operational costs (-)	Subsidies to alleviate costs associated with seed
Size of exploitation (-)	*None identified*
Cover crops and enhanced efficiency irrigation: Controlled deficit irrigation and vegetative cover of adventitious herbs/plant cover planted	
Adoption factors (+ or -)	**Actions**
High provision of inputs (+)	*None identified*
Dissemination of efficiency potential as wind erosion control (+)	Dissemination of successful experience from fellow farmers
Access to technology / machinery (+)	Financial support through grants or subsidies
Lack of enforcement and monitoring (-)	Effective control of current regulations regarding bad practices (burning of stubble, illegal wells, pollution by nitrates)
Farmers' resistance to new practices (-)	Dissemination of successful experience from fellow farmers
Plant cover selection (-)	*None identified*
Lack of training for farmers (-)	Awareness and information campaigns, training of farmers

Recommendations for actions to promote the uptake of SICS

Based on this analysis, and feedback collected from stakeholder, the following recommendations were formulated:

- **Establish mechanisms for effective knowledge dissemination and exchange between farmers:** Some of the practices benefitting soil will require farmers to learn about these techniques, their application to different conditions as well as their benefits in order to change their misconceptions about these methods. To this end, research findings should be made accessible and widely disseminated and educational activities should be encouraged. Knowledge should be disseminated via multiple channels, through the provision of guidance document but also farms visits and demonstration days. Since farmers tend to place a lot of trust in their peers, establishing a network of model farms, for example under the umbrella of the National Action Programme to Combat Desertification, demonstrating how to use and adapt different SICS in the region would effectively support farmers in learning and sharing experiences about these practices.

- **Subsidise transition to practices benefitting soil health:** The uptake of certain SICS, such as cover cropping, enhanced efficiency irrigation and reduced tillage, might require upfront investments, such as the purchasing of additional seeds and new machinery. Grants should be made available to farmers buying new equipment to implement these practices or groups of farmers intending to set up a 'machinery exchange'. Such an exchange could also be set up and managed by the regional/local farm advisory services or municipalities.

- **Strengthen policy enforcement:** While it was found that there are a number of

policies already in place that – directly and indirectly - regulate and incentivse different SICS, stakeholders report that outcomes on soil health are limited due to weak enforcement mechanisms. It is clear mechanisms for checking compliance with existing regulations need to be strengthened and expanded.

- **Make incentives more effective by simplifying application process:** Evidence suggest that economic incentives might not be a key driver for SICS adoption with the current system perceived to be overly bureaucratic by farmers. With the post-2020 CAP, new funding rules funding rules will be introduced. The Good Agricultural Environmental Conditions (GAECs) now offer a greater chance for soil protection. New conditions with the potential to improve soil health have been added, e.g., the new GAEC 7 requires "No bare soil in most sensitive period(s)" (European Commission, 2018b). Cover crops will be an important strategy for meeting this requirement. The payment agencies should seek to simplify procedures for farmers applying for CAP payments in order not to deter farmers from adopting SICS.

Keszthely, Hungary

The main soil threats in the study site "Keszthely", Hungary are soil compaction, the decline of soil organic matter, soil erosion and contamination from nitrates. Problems are caused by intensive land use without nutrient replenishment, lack of organic fertiliser use, inadequate soil cultivation and tillage equipment, SICS tested at the study site are thought to address these threats and include integrated nutrient management measures (*Organic/inorganic N fertilization, mineral fertilisation in continuous maize cropping),* integrated nutrient management in combination with crop rotations (*organic/inorganic fertilisation in different rotations*), and reduced tillage practices (*Tillage in maize-wheat biculture*). (Organic/inorganic N fertilization, mineral fertilisation in continuous maize cropping) and reduced tillage practices (Tillage in maize-wheat biculture).

Policy shortcomings and opportunities

The use of soil-improving cropping practices is regulated and incentivised through a range of existing regulatory, and economic instruments in Hungary, with the exception of smart weed control as well as smart residue and controlled traffic management (shaded in light green) [57]. The analysis shows that several policies cover the SICS trialled at the study site (shaded in dark green): cross-compliance requirements and greening measures established under the CAP incentivise farmers to adopt crop-rotation practices. Nutrient management is regulated through various pieces of water legislation which establish limitations on or requirements or fertiliser (and pesticide). National soil protection legislation mandates the drafting of soil protection plans for a range of agricultural activities and the adoption of measures to protect

[57] See the Annex for a more detailed overview of the policies described in this section.

soil, including reduced/no tillage methods, to mitigate local soil threats.

Table 1: Coverage of SICS in relevant national and regional policies, instruments, and measures in Keszthley, Hungary

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
CAP GAEC Cross-compliance Standards											
Act on the General Rules of Environmental Protection											
Rules for Action Program against Agricultural Nitrate Pollution, Data Reporting and Record Keeping											
Decree on the Protection of Waters against Nitrates Pollution from Agricultural Origin											
Decree on Protection of Geological Medium and Groundwater against Pollution											
Rules about Agricultural Utilization of Sewage Sludge and Waste Water											
Decree authorizing the placing on the market and use of plant protection products and packaging, marking, storage and transport of plant protection											
Rules about Authorization, Storage, Marketing and Utilization of Fertilising Products											
National Action Plan to Improve Organic Farming											
Ministerial Decree on Preparation of Soil Protection Plan											
Act on Cultivated Land											
Act on the Protection of Cultivated Soil											

Evidence gathered through desk research, interviews and a stakeholder workshop show that different factors contribute to and undermine the uptake of SICS in general, and of the practices tested in Keszthely, Hungary in particular. These include:

- Limited coherence between policies
- Weak enforcement
- Availability of grants/subsidies

- Lack of information

Recommendations for actions to promote the uptake of SICS

Based on the analysis of bottlenecks and opportunities in national policy to facilitate the adoption of Soil-Improving Cropping Systems in Hungary, the following recommendations were formulated:

- **Simplification of the policy framework and better enforcement:** Policies are viewed by stakeholders as complicated, incoherent, and poorly enforced. This makes it challenging for farmers to comply with policy requirements, especially if they observe that they face little consequence for non-compliance. While it is found that there are a number of policies already in place that impact soil, they require simplification both at EU and national level legislation. In addition, they need to be more effectively enforced to produce the intended outcomes and impacts. This also concerns ensuring policy is coherent and not working towards contradictory goals.
- **Raising awareness of the environmental benefits of SICS**: There is need to provide farmers with information on SICS. There is very little awareness of the benefits of soil bacteria in the soil and what technique can facilitate its maintenance. Information needs to also be aimed at consumers, who should be encouraged to purchase from sustainably managed farms.
- **Using available funding to promote SICS adoption:** Funding opportunities are the main driver for SICS adoption, especially funding from EU level. With the post-2020 CAP, new funding rules funding rules will be introduced. The Good Agricultural Environmental Conditions (GAECs) now offer a greater chance for soil protection. New conditions with the potential to improve soil health have been added, e.g., crop rotation is introduced under GAEC 8. The new agri-environment-climate measures present opportunities to address declining soil health. Key will be for Member States to allocate enough of the budget available to them to soil health measures.

Veneto, Italy

The soil-improving cropping systems (SICS) tested at the SoilCare study site in Veneto, Italy include cover crops and reduced tillage and aim to address loss of soil-organic matter, the main soil threat found at the study site. They therefore represent important practices that might benefit soil health in the region if widely taken up.

Policy shortcomings and opportunities

The table below provides an overview of policies promoting the full range of SICS covered by the SoilCare project (shaded in light green). The analysis shows that several policies regulate

and incentivse the use of cover crops and reduced tillage, the SICS tested at the study site (shaded in dark green): Cover crops are incentivised through GAEC 4 of the CAPs cross-compliance standards, particularly on land showing signs of erosion. However, cover cropping is not included in the list of EFA options available to Italian farmers. In addition, area-based payments under FA 4C and 5E of the RDP may also be used to incentivise the use of cover crops as well as reduced tillage, the second SICS practice tested at the site. Finally, water policies are also relevant for tillage management in the study site area, which is located in the Nitrate Vulnerable Zone of the Veneto Region which was established in compliance with the Nitrates Directive. The Veneto Region has recently implemented a specific agro-environmental measure to increase soil organic matter content through organic amendment input and conservative tillage.

Table 1: Coverage of SICS in existing national and regional policies, instruments and measures in the Veneto region in Italy

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
CAP GAEC Cross-compliance standards *Decreto 18 gennaio 2018. Disciplina del regime di condizionalità ai sensi del regolamento (UE) n. 1306/2013 e delle riduzioni ed esclusioni per inadempienze dei beneficiari dei pagamenti diretti e dei programmi di sviluppo rurale*											
National CAP rural development programmes 2014-20- *Programmi di Sviluppo Rurale*											
CAP rural development programmes 2014-20 for the Veneto region *Programmi di Sviluppo Rurale Veneto*											
River Basin Management Plan for the Eastern Alps *Piano di Gestione delle Acque, Distretto Idrografico delle Alpi Orientali*											
General criteria and technical standards for the regional regulation of the agronomic use of livestock manure *Criteri e norme tecniche generali per la disciplina regionale dell'utilizzazione agronomica degli effluenti di allevamento*											
Application of the directive 91/676 / CEE on the protection of waters from pollution by nitrates from agricultural sources											

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
Applicazione della direttiva 91/676/CEE sulla protezione delle acque dall'inquinamento da nitrati provenienti da fonti agricole											
Implementation of the directive on the sustainable use of pesticides *Attuazione della direttiva 2009/128/CE che istituisce un quadro per l'adozione comunitaria ai fini dell'utilizzo sostenibile dei pesticidi.*											
Ministerial Decree on the correct use of plant protection products, as well as of the municipal regulation proposal for the use of plant protection products, in application of the National Action Plan for the sustainable use of plant protection products *Indirizzi regionali per un corretto impiego dei prodotti fitosanitari, nonché della proposta di regolamentazione comunale per l'utilizzo dei prodotti fitosanitari, in applicazione del Piano di Azione Nazionale per l'uso sostenibile dei prodotti fitosanitari*											

Evidence gathered through interviews, desk research and a stakeholder workshop shows that different contextual factors contribute to and undermine the uptake of SICS in general, and of the practices tested in the study site in particular. Some of the findings suggest that the uptake of SICSs is improving. On the other hand, barriers to the uptake of these practices remain.

The key factors shaping the success of policy instruments include:

- Limited influx of young farmers prevents change
- Established practices increase need for inputs and heavy machinery
- Lack of a clear vision in policy for sustainable farming
- Complex policies which focus on short-term solutions
- Translation of national policies at regional level creates different outcomes
- No-tillage management and weed control without glyphosate

Recommendations for actions to promote the uptake of SICS

Based on this analysis, and feedback collected from stakeholder, the following recommendations were formulated:

- **Develop horizontal, long-term strategies for sustainable agriculture:** A strategic vision which goes beyond the regional differences and short-term political interest has great potential in facilitating a transition to sustainable agriculture and thus better soil management practices. In the same vein, policies should thrive to be more holistic. The European Farm to Fork Strategy already could provide a starting point for developing such a vision.
- **Flexible but well-informed policy design:** Italy has a great diversity of regions and farming systems, each with their own problems. Policy should take these differences into account so that they do not undermine the successful implementation or lead to success only in the areas which are already progressive. The policy must be based on the identification of problems and designing solutions based on scientific input.
- **Education and training:** More emphasis should be put on training of farmers and consumers. Technical and scientific knowledge provided by regions should be better transmitted to farmers. Some of the practices benefitting soil will require farmers to learn about these techniques, their application to different conditions as well as their benefits in order to change their misconceptions about these methods. To this end, research findings should be made accessible and widely disseminated and educational activities should be encouraged. Knowledge should be disseminated via multiple channels, through the provision of guidance document but also farms visits and demonstration days.
- **Demographic change:** Policies, especially in the long term should aim to make the profession of farming more attractive to young farmers and people who are not farmers by family background. Furthermore, access for those who are willing to take up farming should be facilitated.

Eastern Norway

The soil-improving cropping systems (SICS) tested at "Akershus" in Eastern Norway include measures for compaction alleviation (cover crops, including biological compaction release), soil-improving crops (cover crops and catch crops), and precision agriculture and are thought to address the main soil threats at the site, compaction, erosion, and nutrient loss. They therefore represent important practices that might benefit soil health in the region if widely taken up. The main aim of the work presented here was to formulate policy alternatives and actions at to facilitate the adoption of soil-improving cropping systems.

Policy shortcomings and opportunities

The existing policy framework in Eastern Norway already promotes the SICS covered by the SoilCare project through a range of existing regulatory, economic, and voluntary policy instruments and measures (shaded in light green). The analysis[58] shows that economic instruments promote the use of cover crops, the SICS tested at the study site (shaded in dark green), a practice which is relevant to alleviating compaction, halting erosion, and generally improving soil health. The same instruments incentivse reduced tillage practices which also reduce compaction and erosion while smart residue and controlled traffic management, which could address the same soil threats, are not incentivised, or regulated by existing policies.

Table 1: Coverage of SICS in current regional policies, instruments, and measures in Eastern Norway

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
Regulations on subsidies for regional environmental measures in agriculture *(FOR-2016-04-06-392 Forskrift om tilskudd til regionale miljøtiltak i landbruket, (forskrift om RMP-tilskudd), Oslo og Akershus)*											
Regulation on water management framework *(FOR-2006-12-15-1446 Forskrift om rammer for vannforvaltningen)*											
Regulation on organic fertilisers *(FOR-2003-07-04-951 Forskrift om gjødselvarer mv. av organisk opphav)*											
Regulation on plant protection products (FOR-											

[58] See the Annex for a more detailed overview of the policies described in this section.

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
2015-05-06-455 Forskrift om plantevernmidler)											

Evidence gathered through interviews, desk research and a stakeholder workshop shows that different contextual factors contribute to and undermine the uptake of SICS in general, and of the practices tested in the study site in particular. Some of the findings suggest that the uptake of SICSs is improving. On the other hand, barriers to the uptake of these practices remain.

The key factors shaping the success of policy instruments include:

- Weak financial incentives
- Lack of explicit soil objectives in existing legislation/soil-specific legislation
- Low coherence between policies
- Land tenure
- Lack of knowledge sharing/dissemination
- Climate change impacts

The table below provides an overview of barriers and enablers for the SICS tested at the study site and which were identified by stakeholders during the adoption workshop.

Table 2: Adoption barriers, enablers, and actions to increase uptake of the SICS tested at study site identified by stakeholders: Participants were asked to identify actions for the most important factors affecting SICS adoption; therefore, not all adoption factors were discussed in detail. The effectiveness and feasibility of an action was not assessed.

Compaction alleviation and soil-improving crops (*SICS category: Cover crops*)	
Adoption barriers (-) and enablers (+)	**Actions**
Changing climate – longer growth season (+)	*None identified*
Experiences with compaction damage (+)	More research and awareness (preventive, repairing)
Positive experiences with advisory services and farm visits (+)	More use of farm walks and dissemination of results/reports

Compaction alleviation and soil-improving crops (*SICS category: Cover crops)*	
Access to right information (+)	Wider dissemination of existing knowledge, sharing practices, study visits, increase knowledge about the positive effects of cover crops
Subsidies (+)	Increase the subsidies for cover crops in the Regional Environmental Programme
Costs associated with seeds and financial risks (-)	Increase subsidy rates
Lack of information (-)	Wider dissemination of existing knowledge, sharing practices, study visits, increase knowledge about the positive effects of cover crops
Climate limitations (-)	*None identified*
Design of subsidy schemes limiting use of certain types seeds, methods and dates for sowing due to policy design (-)	Adapt legislation to support practices that are beneficial in the long-term
Lack of experience under Norwegian conditions (-)	Large scale trials with farmers, more research, and long-term experiments Make research results accessible Provide funds to develop a cover crop guideline

Recommendations for actions to promote the uptake of SICS

Based on the analysis of bottlenecks and opportunities in national policy to facilitate the adoption of Soil-Improving Cropping Systems in Eastern Norway, the following recommendations were formulated:

- **Design a more flexible system of economic incentives:** Voluntary financial incentives are the main driver for the adoption of agricultural practices beneficial to soil in Eastern Norway. There is a need to consider the different conditions in which farmers operate (such as differences in tenure) to ensure funding is accessible without creating additional administrative burden. Furthermore, incentives must be adapted to changing conditions such as inflation, so they do not lose their attractiveness over time.
- **Revise the existing policy framework to include ambitious, long-term targets**: Certain policies, most notably economic policy instruments are successful in encouraging farmers to adopt SICS. To expand these positive outcomes, policies may be adapted to accommodate a wider range of farm types and to include more ambitious targets. In addition, experience shows that changes to the policy framework and subsidy schemes, such as the Regional Environmental Programme, could act as a barrier to implementation. Providing sustained funding and legislative security will be crucial in motivating farmers to adapt their practices.

- **Mainstreaming of soil objectives and good soil management practices in existing legislation:** Many benefits to soil health are achieved through other sectoral or environmental policies. While this is not considered a barrier to SICS adoption, there is a risk that key soil threats are not addressed if they do not fall under legislation for other sectors.
- **Establish mechanisms for effective knowledge dissemination and exchange:** There is anecdotal evidence that awareness raising, exchange of practices, guidance from farm advisory services will have an influence in changing farmers' practices by increasing their awareness about the potential benefits of SICS. To this end, research findings should be made accessible and widely disseminated and educational activities should be encouraged. Knowledge should be disseminated via multiple channels, through the provision of guidance document but also farms visits and demonstration days.

Podlasie, Poland

The main soil threats in the study site include:

- **Soil erosion**, due to conventional (plow) tillage on slopes, plant cultivation on steep slopes, inappropriate crop rotation.
- **Soil organic matter decline**, due to monoculture, limited organic fertilization, separation of agricultural and animal production, inadequate use of legume crops to increase nitrogen fixation and reduce fertiliser needs.
- **Soil compaction** caused by heavy equipment, working field with very low/high soil moisture, limited organic fertilization.
- **Soil acidification** due to limited soil liming and organic fertilisation.

SICS that are being tested at the study site are thought to address these soil threats and include integrated nutrient management measures and cover crops. They therefore represent important practices that might benefit soil health in the region if widely taken up. This section takes the policies identified in the previous section and evaluates how they can mitigate the soil threats in the Polish study site region.

Policy shortcomings and opportunities

The table below provides an overview of policies promoting the full range of SICS covered by the SoilCare project (shaded in light green). The analysis shows that several policies regulate and incentivse the use of cover crops and integrated nutrient management, the SICS tested at the study site (shaded in dark green): direct payments, greening measures, and rural development plans under the CAP all provide financial rewards to farmers adopting cover

cropping, although mostly only on sloppy areas and areas at risk of water erosion. Irrigation management is heavily regulated through multiple pieces of legislation, mainly with the aim of protecting water, and to a limited extent, soil quality.

Table 1: Coverage of SICS in current national and regional policies, instruments, and measures in Podlasie, Poland

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
National policies											
CAP GAEC Cross-compliance Standards *(Normy i wymogi wzajemnej zgodności)*											
CAP Greening Payment Requirements *(Normy i wymogi wzajemnej zgodności WPR: zazielenienie, wymagania dotyczące płatności)*											
Rural Development Program for the years 2014-2020 *(Program Rozwoju Obszarów Wiejskich na lata 2014-2020)*											
Code of Good Agricultural Practice *(Kodeks Dobrej Praktyki Rolniczej)*											
Act on Organic Agriculture *(Ustawy o rolnictwie ekologicznym)*											
Environmental Protection Act *(Ustawa Prawo ochrony środowiska)*											
Act on Water *(Ustawa Prawo Wodne)*											
Waste Act *(Ustawa o odpadach)*											
Plant Protection Products Act *(Ustawy o środkach ochrony roślin)*											
Fertilisers Act *(Uustawa o nawozach i nawożeniu)*											
Nature Conservation Act *(Ustawa o Ochronie Przyrody)*											

Evidence gathered through interviews, desk research and a stakeholder workshop shows that different contextual factors contribute to and undermine the uptake of SICS in general, and of the practices tested in the study site in particular. Some of the findings suggest that the uptake of SICSs is improving. On the other hand, barriers to the uptake of these practices remain.

The key factors shaping the success of policy instruments include:

- Lack of economic benefits and incentives
- Limited access to manure
- Time needed to meet organic production standards

- Limited policy coherence
- Lack of knowledge about SICS
- Unfavorable environmental conditions

The table below provides an overview of barriers and enablers for the SICS tested at the study site and which were identified by stakeholders during the adoption workshop.

Table 2: Adoption barriers, enablers, and actions to increase uptake of the SICS tested at study site identified by stakeholders: To assess the effectiveness and feasibility of an action, a scale from 1 (not at all effective/feasible) to 4 (highly effective/feasible) was proposed but not applied in the stakeholder workshop due to time constraints

Fertilisation/amendments: cover crops, liming, manure	
Adoption factors (+ or -)	**Actions**
Energy v agriculture policy - the use of harvest residues for biogas production competing with the use in agriculture (-)	Improve the current policy, institutional, administrative, technical, and economic set up to enable organic agriculture to develop.
Low level of knowledge amongst farmers to support SICS adoption (-)	Awareness raising increase training and educational activities and support with a view to educate farmers about SICS and their benefits including organic agriculture.
Weak cooperation between advisory services and universities to promote soil quality problems and support SICS adoption (-)	Strengthen the cooperation between advisory services and universities to promote soil quality problems and support SICS adoption.
High price for conservation tillage implementation (-)	Improve economic attractiveness of implementing certain SICS such as cover crops and crop rotation and reduce technical barriers and stimulate the price for conservation tillage practical implementation
Limited access to organic fertilisers resulting from the separation of agricultural and livestock production (-)	Improve the current policy, institutional, administrative, technical, and economic set up to enable organic agriculture to develop

Recommendations for actions to promote the uptake of SICS

Based on this analysis, and feedback collected from stakeholder, the following recommendations were formulated:

- **Subsidise transition to practices benefitting soil health:** the uptake of certain SICS, such as cover cropping, might require upfront investments, such as the purchasing of additional seeds and new machinery. Grants should be made available to farmers buying new equipment to implement these practices or groups of farmers intending to set up a 'machinery exchange'. Such an exchange could also be set up and managed by the regional/local farm advisory services or municipalities.
- **Increase policy coherence:** there needs to be coherence between different sectoral policies (e.g., energy and agriculture), as well as steps taken to ensure farmers can easily adopt new practices policies without undue administrative burdens.

- **Offer regular training and information services to keep farmers informed about new developments and insights:** dissemination of knowledge, awareness raising, and education are important components of policy interventions and they should be used in parallel with economic and legislative instruments. Some of the practices benefitting soil will require farmers to learn about these techniques, their application to different conditions as well as their benefits in order to change their misconceptions about these methods. To this end, research findings should be made accessible and widely disseminated and educational activities should be encouraged. Knowledge should be disseminated via multiple channels, through the provision of guidance document but also farms visits and demonstration days.

Caldeirao, Portugal

The main soil threats in Caldeirão study site include:

- soil compaction – caused harrowing, traditional tillage, and compaction caused by lifestock (due to very soaked ground in winter)
- Erosion – primarily resulting from intense rain in winter
- Pollution/contamination of soil/water – caused by residues from wastewater treatment plants (sludge), plant protection products, and nitrates
- Low soil organic matter content (estimated to be below 2%)
- Acidification and low soil microbial diversity

SICS that are being tested at the study site are thought to address these soil threats and include soil improving crops (Organic rice in rotation with perennial lucerne and Conventional grain corn in succession with legumes winter cover) and integrated nutrient methods (Conventional grain corn fertilised by urban sludge). They therefore represent important practices that might benefit soil health in the region if widely taken up.

Policy shortcomings and opportunities

The table below provides an overview of policies regulation, incentivsing, and promoting the full range of SICS covered by the SoilCare project (shaded in light green). The analysis shows that several policies regulate and incentivse the use of cover crops, crop rotations and integrated nutrient management, the SICS tested at the study site (shaded in dark green): direct payments, greening measures, and rural development plans under the CAP all provide financial rewards to farmers adopting crop rotation and cover crops. Nutrient input in agriculture is regulated through several pieces of legislation, mostly with a view to protecting water quality rather than soil, such as the national Water Law, regulations dealing with the sustainable use of pesticides, sewage sludge, and nitrates on agricultural land

Table 1: Coverage of SICS in current national and regional policies, instruments, and measures in Caldeirão (PT)

Policy	Crop rotation	Green manures, cover crops,catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
CAP - Complementary National Direct Payments Requirement (Greening included)											
Cross compliance - Statutory Management Requirements (SMR) and standards of good agricultural and environmental condition (GAEC).											
CAP - Rural Development Proramme 2014 - 2020											
National Water Law											
National Nitrates Directive - Law on the Protection of Water from Pollution Caused by the Use of Nitrates in Agriculture											
National Groundwater Law											
National legal framework for agricultural use of sewage sludge											
National sustainable Use of Pesticides Law											
National Action Program to Combat Desertification (PANCD)											

Evidence gathered through interviews, desk research and a stakeholder workshop shows that different contextual factors contribute to and undermine the uptake of SICS in general, and of the practices tested in the study site in particular. Some of the findings suggest that the uptake of SICSs is improving. On the other hand, barriers to the uptake of these practices remain.

The key factors shaping the success of policy instruments include:

- Funding priorities
- Costs of adopting SICS
- Economic incentives mostly reward existing practices
- Lack of knowledge and technical support
- Policy instruments not flexible enough to take into account regional/structural

differences

- Bureaucratic permitting procedures for sewage sludge application
- Unwillingness to give up traditional practices
- Limited influence of producer organisations
- Lack of monitoring and enforcement
- Market demands/pressures

The table below provides an overview of barriers and enablers for the SICS tested at the study site and which were identified by stakeholders during the adoption workshop.

Table 2: SICS being tested, adoption factors (enablers or barriers) and actions to overcome the barriers: Participants were asked to identify actions for the most important factors affecting SICS adoption; therefore, not all adoption factors were discussed in detail. To assess the effectiveness and feasibility of an action, a scale from 1 (not at all effective/feasible) to 4 (highly effective/feasible)

Soil improving crops: Legumes green manure			
Adoption factors (+ or -)	**Actions**	**Effectiveness**	**Feasibility**
Lack of subsidies (-)	*None identified*		
Mild climate (+/-)	*None identified*		
Cost and access to seeds (-)	Develop national seed multiplication programs,	3	3
Lack of farmer interest and supportive networks (-)	Create a network of national trials that allows adapting the technique to each region, according to the characteristics of each area.		
Lack of training in green fertilisation (-)	Implement/ finance projects to compile existing information, implement/maintain demonstration areas; dissemination at fairs, workshops for the public, farmers, technicians, as well as promote in schools (textbooks, field trips).	4	2
Green manure technique lost (-)	Implement/ finance projects to compile existing information, create a network of national trials to adapt technique to regional conditions	4	3
Difficult to access relevant information / specific documents for the Baixo Mondego region (-)	*None identified*		
No political incentives to adopt the green manure technique (-)	Create operational groups (politicians, technicians, and farmers), to (i) envisage the technique at a more global level, with the orientation of the country's policies, changing the course to current practices; (ii) invest in increasing soil fertility and the quality of the environment, in general; and (iii) stop unconditionally financing less favorable techniques , priority should be given to conservation farming techniques that are also able to be a source of food production that is both profitable and sustainable	3	3
Soil imroving crops: Organic rice in rotation with Lucerne			
Adoption factors (+ or -)	**Actions**	**Effectiveness**	**Feasibility**
Cost for organic certification in small areas, organic ferilizeation and labour (-)	Review certification costs for small areas. Land reparcelling is the only way to solve many problems arising from the mini-fundio but it is a political measure	4	1
High cost of installing lucerne (-)	*None identified*		

Subsidies in place for rice cultivation (+)	*None identified*		
Economic value underestimated (-)	Communicate the quality of products to justufy higher prices (together with cooperatives or producer associations)	4	2
Favourable climate and soil conditions (+)	*None identified*		
Weed management (more pests attacking organic rice) (-)	New techniques explored, e.g. planting rice instead of sowing it	2	2
New generation of farmers open and interested to try this technique (+)	*None identified*		
Technical support from cooperatives, open days (+)	Need for more specific training organisation for technicians and farmers	4	3
Policy support for organic rice cultivation (+)	Strengthen incentives with the new CAP at national or regional level with specific funds	4	1
Fertilisation/amendments: Organic amendment with sludge			
Adoption factors (+ or -)	**Actions**	**Effectiveness**	**Feasibility**
Low cost for farmer (+)	Agricultural valorisation is a good solution for WWTPs and advantageous for the farmer who keeps organic matter at almost zero cost.	4	4
Lack of knowledge about the sludge application and need for a specific machinery (-)	It is necessary to make farmers aware of the environmental risks of poor application of sludge (eg inadequate quantities, under inappropriate climatic conditions) and to hold them accountable for application practices. Mandatory training for those who have an approved sludge management plan	4	3
Bad smell of sludge	Improve the stabilisation of organic matter, through digestion, dehydration, and / or by composting	3	2
High bureaucracy (administrative permits for the sludge application) (-)	Simplification of the management plan approval process is necessary.	3	2
Specific rules for sludge application (crop type, soil type, quantities, application dates, waiting times before sowing) (-)	*None identified*		
Lack of knowledge about the environmental benefits (-)	Dissemination of the results of studies on the impact of sludge on soils in seminars or dissemination to the general public, in order to demystify the use of sludge. Explain that risks are controlled through the sludge management plan.	3	2
Easy access to information (+)	*None identified*		
Bad reputation of sludge application amongst the public and farmers (-)	*None identified*		
Strict and complicated legislation (-)	*None identified*		

Recommendations for actions to promote the uptake of SICS

Based on this analysis, and feedback collected from stakeholder, the following recommendations were formulated:

- **Design targeted incentives that reward uptake of appropriate practices:** As mentioned above, subsidies and other economic incentives play a large role in

Portuguese agriculture, however, evidence suggests that financial measures might finance practices already in place or which are not appropriate in specific locations. At the same time, regional and local policies must be flexible enough to allow for regional differences. A financial measure on cover crops may well be appropriate in the south of the country, but less appropriate in the north. Financial incentives need to be more targeted, both tied to specific actions and region (or environmental/geographic conditions) to result in the desired change. Priority should be given to conservation farming techniques that are also able to be a source of food production that is both profitable and sustainable.

- **Strengthen policy enforcement:** While it was found that there are several policies already in place that – directly and indirectly - regulate and incentivse different SICS, stakeholders report that outcomes on soil health are limited due to weak implementation and enforcement mechanisms. It is clear mechanisms for checking compliance with existing regulations need to be strengthened and expanded. With the post-2020 CAP, new funding rules funding rules will be introduced. The Good Agricultural Environmental Conditions (GAECs) now offer a greater chance for soil protection. New conditions with the potential to improve soil health have been added, e.g., the new GAEC 7 requires "No bare soil in most sensitive period(s)". Cover crops will be an important strategy for meeting this requirement. The payment agencies should seek to ensure that these conditions are complied with and verified through, e.g., more frequent inspections and farmer reporting (including for example images of the implemented practices).
- **Subsidise transition to practices benefitting soil health:** The uptake of certain SICS might require upfront investments, such as the purchasing of seeds or new machinery. Grants should be made available to farmers buying new equipment to implement these practices or groups of farmers. A revision of certification costs might encourage a move to organic production, such as organic rice cultivation tested at the study site. Land reparcelling and the establishment of a national national seed multiplication program were identified as actions which could facilitate a transition and reduce costs in the long run.
- **Simplification of permitting procedures for sewage sludge application:** a simplification of permitting and management plan approval process is necessary, as currently, many farmers prefer to avoid bureaucratic complications related to the use of sludge, even if it is free.
- **Establish mechanisms for effective knowledge dissemination and exchange between farmers:** Some of the practices benefitting soil will require farmers to learn about these techniques, their application to different conditions as well as their benefits

(and risks) to change their misconceptions about these methods. To this end, research findings should be systematically compiled, and widely disseminated and educational activities should be encouraged. Knowledge should be disseminated via multiple channels, through the provision of guidance document but also farms visits, demonstration days, and social media. Since farmers tend to place a lot of trust in their peers, establishing a network of model farms demonstrating how to use and adapt different SICS in the region would effectively support farmers in learning and sharing experiences about these practices.

- **Invest in and build capacity of Farm Advisory Services**: like framers, farm advisors also need to learn about new practices, their practical application, costs, and benefits to support farmers they assist. Strengthening the technical skills of farm advisory services and setting up mechanisms for continuous learning are therefore crucial.
- **Communicate environmental benefits generated by SICS:** high-quality products need to be sold at fair process which compensate farmers for the benefits they generate for the environment and society as a whole. The prospect of a fair price for a product stemming from sustainable practices will make their uptake more appealing to farmers. It will be equally important to continue to educate consumers about the advantages and disadvantages of conventional farming practices vs. sustainable practices to ensure increased demand for sustainably produced products and encourage the retail sector to make these more widely available to all sections of society. To this end, cooperatives or producer associations play a major role in marketing these products, explaining production methods – especially important for practices such as sewage sludge application which might perceived as a high-risk technique – and negotiating prices with retailers.

Draganesti Vlasca, Romania

Soil quality at the Draganesti Vlasca study site is affected by compaction, temporary water deficit and excess as well as erosion. The soils in the area are naturally susceptible to compaction and water excess and/or deficit due to their high clay content. The Soil-improving cropping system (SICS) tested at the study site and which is thought to address these soil threats includes reduced tillage measures which therefore represent important practices that might benefit soil health in the region if widely taken up.

Policy shortcomings and opportunities

The table below provides an overview of policies regulation, incentivsing, and promoting the full range of SICS covered by the SoilCare project (shaded in light green) as well as the SICS tested at the study site (shaded in dark green): reduced tillage. The Code of Good Agricultural Practice established in compliance with the EU Nitrates Directive lists reduced tillage as good

practice to be adopted by farmers. However, the Code is not mandatory to farmers outside of Nitrate Vulnerable Zones. In addition, reduced tillage practices are incentivised through the RDP. Crop rotation is promoted through water (and soil) protection policies such as the Action Plan for the Protection of Waters Against Pollution Caused by Nitrates, the CAP's greening measures, GAEC cross-compliances standards and the RDP. The RDP, specifically through its agri-environment and climate measures incentivises the use of nitrogen-fixing cover crops to reduce nutrients run-off and leaching, increase organic matter content and soil nutrients. In case of the study site area, where there are clay soils, the promotion of this practice has multiple benefits for soil quality according to stakeholders, since it increases the aeration of soil and reduces erosion on top of the positive impacts identified above. Integrated nutrient management is not only incentivised through the CAP (GAEC 6), but there are also several water and environmental policies, including the Water Act, the Nitrates Action Plan, and the Groundwater Protection Plan, limiting or banning the use of fertilisers in certain areas. However, according to one interviewee, conflicts are placed on farmers related to the compliance with the periods when fertilisers application is restricted, which are established in the Code of Good Agricultural Practices for water protection against nitrates pollution from agricultural sources. The policies just mentioned also directly encourage the use of integrated pest management practices. In addition, several dedicated pieces of legislation regulate the use of plant protection products.

Table 1: Coverage of SICS in current national and regional policies, instruments, and measures in Draganesti Vlasca, RO

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
CAP GAEC Cross-Compliance Standards											
National Program for Rural Development 2014-2020											
Ordinance on organic products no. 34/2000 modified by Ordinance no. 29/2014											
Ordinance no. 990/1809/2015 related to approval of Code of Good Agricultural Practices for water protection against nitrates pollution from agricultural sources											
Water Law no. 107/1996 modified and improved in 2017											

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
National Plan for Groundwater Protection Against Pollution and Deterioration (2009)											
Order for the approval of the Technical Norms regarding the protection of the environment and especially of the soils, when the sewage sludges are used in agriculture, with the subsequent modifications											
Ordinance no. 34/2012 for establishing the institutional framework for sustainable use of pesticides in Romania											
Decision no. 683/2013 for approving the National Action Plan on reducing the risks of using pesticides											
Ordinance no.12/2006 on establishing the maximum levels of pesticides in and on fruits, vegetables, cereals and other plant products											
Ordinance no. 1261/2007 on the establishment of measures for the application of Regulation (EC) no. 2003/2003 of the European Parliament and of the Council of 13 October 2003 on fertilisers											
Ordinance no. 756/1997 on Environmental Pollution Assessment											

Evidence gathered through interviews, desk research and stakeholder workshops shows that different contextual factors contribute to and undermine the uptake of SICS in general, and of the practices tested in the study site in particular. Some of the findings suggest that the uptake of SICSs is improving. On the other hand, barriers to the uptake of these practices remain.

The key factors shaping the success of policy instruments include:

- Outdated legislation
- Lack of dedicated soil policy
- Exploitation of policy synergies
- Availability of financial incentives

- Educated and innovative young farmers

Recommendations for actions to promote the uptake of SICS

Based on this analysis, and feedback collected from stakeholder, the following recommendations were formulated:

- **Update existing policy instruments**: some key policy instruments, such as the National Nitrates Action Plan, seem to be outdated. These need to be revised to reflect current needs, objectives and taking into account new insights on agricultural practices which should be promoted to meat policy objectives.
- **Mainstreaming of soil objectives and good soil management practices in existing legislation:** Many benefits to soil health are achieved through other sectoral or environmental policies. While this is not considered a barrier to SICS adoption, there is a risk that key soil threats are not addressed if they do not fall under legislation for other sectors. The development of a dedicated soil policy should be considered. Such an intervention should be designed to accommodate farm diversity, featuring a robust monitoring and enforcement system.
- **Education and training:** younger farmers seem to be willing to take up new practices. It could be considered as to whether older generations can also be targeted to bring about change faster. Some of the practices benefitting soil will require farmers to learn about these techniques, their application to different conditions as well as their benefits in order to change their misconceptions about these methods. To this end, research findings should be made accessible and widely disseminated and educational activities should be encouraged. Knowledge should be disseminated via multiple channels, through the provision of guidance document but also farms visits and demonstration days.

Skane County, Southern Sweden

The main soil threat in the region where the study site is located is soil compaction. SICS that are being tested within the context of the SoilCare project include sub-soil loosening which is composed of two treatments: subsoil loosening, and subsoil loosening combined with the injection of organic material (straw pellets). In addition, several long-term experiments (LTE) with various crop rotation, use of animal manure, no removal of crop residues in non-manured plots, and regular lime applications are trialed at the study site. The methods tested through SoilCare and LTE therefore present important practices that might benefit soil health in the region if widely taken up

Policy shortcomings and opportunities

The table below provides an overview of the extent to which policies promote the full range of SICS covered by the SoilCare project (shaded in light green). The analysis shows that several policies regulate, incentivise and encourage the use of cover crop, crop rotation, integrated nutrient and pest management practices as well as reduced tillage management. The SICS tested at the study site (shaded in dark green): are subsidised through the different CAP instruments, primarily the greening measures which provide financial rewards to farmers adopting reduced tillage practices, crop rotations and catch crops. In addition, several national policies and initiatives regulate and promote the application of integrated nutrient measures and crop rotation. There are no policy instruments that would explicitly encourage, regulate, or incentivise smart residue management practices.

Table 1: Coverage of SICS in existing national and regional policies, instruments and measures in Skåne County, Southern Sweden

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency irrigation	Controlled drainage	Reduced tillage	Integrated pest management	Smart weed control	Smart residue management	Controlled traffic management	Integrated landscape management
CAP GAEC Cross-Compliance Standards											
CAP Greening Requirements											
Rural Development Programme 2014 - 2020											
Focus on Nutrients Initiative											
Environmental Quality Objectives											
National Action Plan for the Sustainable Use of Pesticides 2013–2017											

Research indicates that there are several factors that shape the success or failure of policy instruments in Southern Sweden, and the uptake of SICS tested in the sites in general. These factors include:

- Farmers' perception of new innovative techniques
- Inflexible subsidy system
- Lack of compensation for all soil benefits delivered

- Well-functioning but limited advisory services

Recommendations for actions to promote the uptake of SICS

Based on the analysis, and feedback collected from stakeholders, the following recommendations were formulated:

- **Set up a more flexible subsidy system:** payments for farmers should cover the use of a larger group of cover crops and taking into account local conditions. Currently, the system only provides subsidies for a restricted number of cover crop species which are not necessarily the most appropriate for the area and individual farms.
- **Review and broaden the practices and associated environmental benefits eligible for payments:** already in 2015, the Environmental Quality Objectives report emphasised that payments under the CAP should provide more targeted support and higher levels of compensation for farmers who deliver greater environmental benefits. The proposed post-2020 CAP, and most notably the Strategic Plans which Member States will need to draft, provide greater flexibility to define the requirements farmers will need to meet in order to receive CAP funding. This opens up opportunities to review and broaden the practices and environmental benefits farmers will need to deliver in order to receive payments. Cropping systems which produce important benefits such as sequestering carbon and which are currently not covered by subsidies, could be added to the measures available to farmers applying for CAP payments.
- **Establish mechanisms for effective knowledge dissemination and exchange between farmers:** some of the practices benefitting soil will require farmers to learn about these techniques, their application to different conditions as well as their benefits to change their misconceptions about these methods. This is for example the case in Swedish study site where a new "non traditional" sub-soiling technique is being tested. In addition, since farmers tend to place a lot of trust in their peers, establishing a network of model farms demonstrating how to use and adapt different SICS in the region would effectively support farmers in learning and sharing experiences about these practices. These activities could be linked to already existing courses organised by the region to provide training to farmers on sustainable agricultural practices.
- **Invest in and build capacity of Farm Advisory Services:** like farmers, farm advisors also need to learn about new practices, their practical application, costs, and benefits to support farmers they assist. Strengthening the technical skills of farm advisory services and setting up mechanisms for continuous learning are therefore crucial.
- **Update summary papers explaining and presenting data as well as conclusions**

from the Swedish long-term field experiments: findings from the Swedish Long-term field experiments should be made accessible and widely disseminated, both to farmers and advisory service workers as these results demonstrate the benefits of SICS and their applicability in the region.

English East Midlands, UK

The soil-improving cropping systems (SICS) tested at the SoilCare study site "Loddington" located in the English East Midlands (UK), test measures for compaction alleviation in no tillage systems (*ploughing, low disturbance sub-soiling and mycorrhizal inoculant*), and soil-improving crops (*incorporation of deep-rooting grass leys into arable rotations).* SICS were selected to address the main soil threats found at the site: compaction, low soil organic matter and blackgrass. They therefore represent important practices that might benefit soil health in the region if widely taken up. The main aim of the work presented here was to formulate policy alternatives and actions and to facilitate the adoption of soil-improving cropping systems.

Policy shortcomings and opportunities for facilitating the uptake of SICS

SICs adoption is already promoted through a range of existing regulatory, economic, and voluntary policy instruments and measures in the English East Midlands (shaded in green). The analysis shows that several policies address the SICs that were tested in the study site: the incorporation of grass leys into arable rotations is incentivised under the CAP's cross-compliance standards as well as the Rural Development Programme for England 2014 - 2020, although deep-rooting cultivars are not specifically supported. Reduced or no tillage is encouraged by some policies, but mandatory requirements or economic incentives are not established by any of the policies analysed.

Table 1: Coverage of SICS in current regional policies, instruments, and measures in the English East Midlands (UK)

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency	Controlled drainage	Reduced or no- tillage	Integrated pest	Smart weed control	Smart residue management	Controlled traffic	Integrated landscape management
CAP GAEC Cross-compliance Standards											
The Guide to Cross-compliance in England 2017											
CAP Rural Development Programme 2014 - 2020											
Countryside Stewardship											

Policy	Crop rotation	Green manures, cover crops, catch crops	Integrated nutrient management	Enhanced efficiency	Controlled drainage	Reduced or no- tillage	Integrated pest	Smart weed control	Smart residue management	Controlled traffic	Integrated landscape management
Organic regulation											
Nitrate Pollution Prevention Regulations											
Plant Protection Products Regulations											
Pesticides Control legislation											
Campaign for the Farmed Environment											
Water Environment Regulations											
Sludge Regulations											

Evidence gathered through desk research, interviews and a stakeholder workshop show that different factors contribute to and undermine the uptake of SICS in general, and of the practices tested at Loddington in particular. These include:

- Lack of soil-specific policies
- Extent of farmer input to policymaking
- Limited coherence between policy instruments
- Lack of monitoring and enforcement
- High adoption costs
- Limited flexibility of financial instruments
- Pressure from market demands
- Lack of education and training

The table below provides an overview of barriers and enablers for the SICS tested at the study site and which were identified by stakeholders during the adoption workshop.

Table 2: Adoption barriers, enablers, and actions to increase uptake of the SICS tested at study site identified by stakeholders: Participants were asked to identify actions for the most important factors affecting SICS adoption; therefore, not all adoption factors were discussed in detail. The effectiveness and feasibility of an action was not assessed.

Soil-improving crops: Introduction of grass leys in rotation	
Adoption barriers (-) and enablers (+)	**Actions**
Simple to implement with existing practices (+)	*None identified*
May offer blackgrass control measure (+)	*None identified*
Limited knowledge of costs/benefits (-)	Identify/demonstrate benefits, e.g., for nutrition quality

Lack of awareness about financial support (-)	Make funding available for public benefits delivered, e.g., contribution to flood control; ensure wider reach of available guidance and handbooks for farmers
Lack of legislation protecting the soil (-)	Design soil specific legislation, taking into account climate change
Lack of knowledge about soil (-)	Training of farmers, wider use of bottom-up voluntary initiatives
Crops grown at unsuitable places due to high market demand (-)	Using payments to encourage sustainable crops to counter market forces or actively discouraging certain crops with higher taxes
Lack of monitoring for funding schemes (-)	Better monitoring of funding schemes to ensure farmers are fulfilling their obligations
Might not be attractive to wholly arable farmers (-)	*None identified*
Conflicts with objective of increasing food supply (cereal yield decline at catchment scale) (-)	*None identified*
5-year rule for permanent pastures (-)	*None identified*
Stewardship scheme prevents conservation of forage (-)	*None identified*
Compaction alleviation experiments: Plough, sub-soiling and mycorrhizal inoculation	
Adoption barriers (-) and enablers (+)	**Actions**
Sub-soiling acceptable agronomic / known practice (+)	*None identified*
Limited knowledge of costs/benefits (-)	Research/demonstrate benefits of application in the region
Not applicable to all soils (shallow/stony soils) (-)	*None identified*
Lack of knowledge of practical application in combination with inoculant (-)	Knowledge transfer needed through advisory services
Availability of equipment needed (-)	*None identified*

Recommendations for actions to promote the uptake of SICS

Based on this analysis, and feedback collected from stakeholder, the following recommendations are formulated. Whilst the actions outlined here specifically aim to promote the uptake of the practices tested at Loddington, they are likely to encourage the adoption of soil-improving cropping systems in general.

- **Consider the development of a dedicated soil policy:** legislation focusing on soil is needed for a more concrete impact on farmers and the adoption of SICS. Such an intervention should be designed to accommodate farm diversity, featuring a robust monitoring and enforcement system. The 25-year Environmental Plan (25YEP) provides an important step in the right direction, but appropriate management approaches, instruments, and metrics are needed, which are commitments established by the 25YEP. While SMR's (Statutory Management Requirements) will be preserved in English law following Brexit, a similar mechanism to preserve the aims of the GAECs is needed.

- **Increase policy coherence:** some of the soil-improving practices might not align with

existing policy objectives. For example, a reduced yield (but increased soil quality) contrasts with the aim of increasing food production. By the same token, some policy objectives foster unsustainable agricultural practices. Policy conflicts and synergies therefore need to be carefully analysed and aligned, in order not to discourage the transition to sustainable farming practices. Ultimately, this might require a prioritisation of certain objectives and targets (and operationalised by the right policy interventions) as a certain level of conflict is unavoidable to ensure the right balance between environmental, social, and economic sustainability. On a practical level, it is important for farmers to have clear, unambiguous information on the legal conditions they need to comply with – especially if they are tied to subsidies - and those that may be rewarded.

- **Make economic instruments more flexible to provide tailored support to farmers transitioning to sustainable practices:** financial instruments should allow long-term change in practices rather than finance one off interventions. They should be designed in a way that offers integral solutions to farmers, for instance they should cover costs associated with machinery or other investments associated with change, which are important barriers for formers.
- **Reward farmers for benefits delivered to society (and discourage unsustainable practices):** make funding available for public benefits delivered to compensate for a potential reduction in yield. At the same time, soil-improving cropping systems should be encouraged to counter market forces which pressure farmers into unsustainable production and an overexploitation of their natural resources.
- **Offer regular training and information services to keep farmers informed about new developments and insights:** dissemination of knowledge, awareness raising, and education are important components of policy interventions and they should be used in parallel with economic and legislative instruments. Regular training, informative sessions on latest innovations are preferred to one off training sessions which have limited impact.
- **Engage with farmers and trusted organisations to deliver advice and training:** Peer to peer learning and bottom-up initiatives are powerful tools to deliver knowledge to farmers as they play a great degree of trust in their fellow producers. Partnering with farmers willing to pioneer new techniques or trusted organisations, such as the Campaign for the Farmed Environment (CFE), will ensure that target audiences are reached, and new information is heard.
- **Demonstrate the costs and benefits of new practices:** the advantages and disadvantages of the soil-improving cropping systems trialled at the study site are poorly understood by farmers. They should be widely communicated, and ideally

demonstrated with field visits, to farmers in the region, by the advisory services, farmers with first-hand experience with these techniques, and other organisations trusted by the farming community.

Annex III: Screen captures from EU level workshops

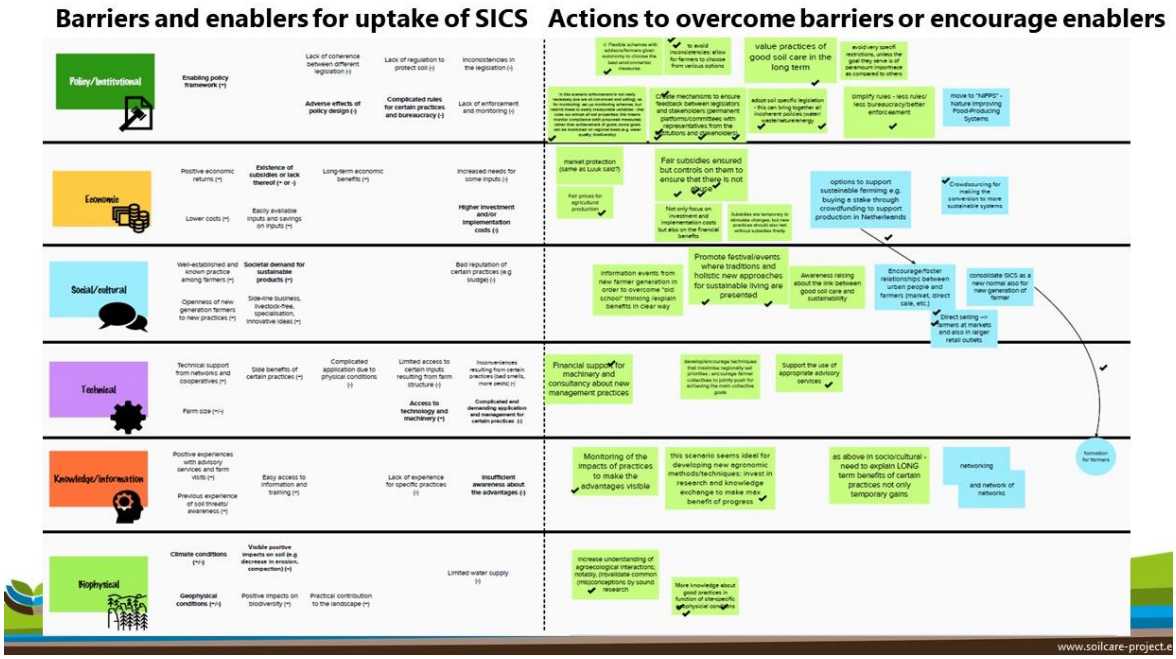

Figure 10: Mural screen capture from the morning session of the 2nd Workshop. The participants suggested actions to overcome the barriers and promote the enablers identified during the study

Figure 11: Mural screen capture from the afternoon session of 2nd Workshop. The participants voted on the likelihood of success of the selected actions under each scenario