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European Joint Programme

Towards climate-smart sustainable management of agricultural soils

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List of acronyms and abbreviations

WP	Work Package
EU	European Union
MS	Member State
C	Carbon
SOC	Soil Organic Carbon
SOM	Soil Organic Matter
CAP	Common Agricultural Policy
ES	Ecosystem Services
EFA	Ecological Focus Area
GAEC	Good Agricultural and Environmental Conditions
UK	United Kingdom
LULUCF	Land Use, Land Use Change & Forestry
GHG	Green House Gas
GAP	Good Agricultural Practice for Protection of Waters
POM	Particulate Organic Matter
SMR	Statutory Management Requirements
CC	Climate Change

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1. Executive Summary

The overall aim of EJP SOIL WP 8 - Science to policy interaction, is to support a strengthened science-policy interface in the area of agricultural soil management and climate change mitigation and adaptation. EJP SOIL Task (T) 8.2 - Understand & Analyse, is focused on developing new insights and understanding of policymaker needs from research related to soil health, soil C accounting and ecosystem services provision by agricultural soils. These policymaker needs encompass different aspects of the policy cycle, including supporting policy development and monitoring, reporting and verification information.

This report details the outcomes of EJP SOIL T8.2.1 Needs Analysis and T 8.2.2 Support for dialogue on policy needs (Deliverable 8.2). Task 8.2.1 was completed via Survey Instruments that were sent to the thirteen participating EJP SOIL consortium members and responses were received from twelve members. This Needs Analysis Survey Instrument was described in detail in Deliverable 8.1 and the responses from that survey are used as the empirical data for some sections of this report. The survey instrument was developed to assess the key policy stakeholder needs and comprised of 4 sections; A) background information, B) policy framing and barriers to implimentation of existing policy targets, C) horizon scanning for emerging policies, and D) Co-innovation, knowledge needs and requirements for implementation of emerging policies.

Sub-Task 8.2.2 involved Policy Forums carried out at an EU level as well as a National level in three EJP SOIL partner countries: Ireland, Italy & Latvia. The EU forum consisted of two sessions:1) Identifying current policy ambitions and future soil aspirational goals and 2) Aligning EJP SOIL research with EU Policy Stakeholder needs and requirements for emerging and future soil policy. It is described in detial in Deliverable 8.2.

The findings and implications from the results of Sub-Tasks 8.2.1 & 8.2.2 are presented in this report, Deliverable 8.3 Summary Report on Needs Analysis. Deliverable 8.3 is structured into sections based on the three categories of needs set out in the deliverable description: 1) Priority needs as expressed by stakeholders, 2) Priority needs for new research and 3) Priority needs for enhanced access to available results and knowledge. The relevant results from Sub-Tasks 8.2.1 & 8.2.2 were sorted into the corresponding overarching sections of this report. Additionally, a fourth section was added to the report, corresponding to the data received from section D) of the Need Analysis Instrument which gathers information on emerging policies across the five EJP SOIL policy domains: 1. Climate change mitigation, 2. Climate change adaptation, 3. Avoiding land degradation, 4. Ecosystem services and 5. Food Security.

Discussions with stakeholders have indicated a significant need for scientific data and tools at both national and regional scales e.g. risk assessment and decision support tools. A need for greater cross collaboration and communication between countries, scientists and policy makers was emphasised, especially as it relates to soil biodiversity and ecosystem services. The inclusion of farmers in policy development was underscored at the EU forum and national forums indicated the need to provide farmers with site-specific recommendations and management strategies. Survey responses indicated that the gaps in policy target realisation were generally moderate to very large, regardless of country or identified policy. In an attempt to target those areas identified as contributing the most to current gaps in policy, the focus moving forward should be on harmonization and communication of scientific data as well as the identification of appropriate incentives (e.g. monetary compensation for farmers) through further research.

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Several needs for new research became known via the forums including the need for the definition and development of assessment tools and indicators for ecosystem services, development of risk management tools, and cohesive plans capable of addressing multiple targets simultaneously. Among the survey instrument responses, several policy targets were repeatedly identified as requiring the development of a measureable indicator for assessing target realisation including:
Limit/ exclude C leakage where incoherence at a global scale is found (Green Deal)
Climate change adaptation utilizing nature based solutions (Green Deal)
Farm advisory service (Common Agricultural Policy).

To facilitate increased access to existing knowledge and data the creation of databases was suggested both at the European and at national levels to allow for increased access to data that is essential for policy development. One example was the suggested creation of a Soil Observatory in Italy which "should include not only pedologists, but also experts on other soil related thematic areas, such as environment, ecology and agricultural economics". Additionally stated in the forums was the need for "common definitions, metrics and tools" this was further supported at a member state level with almost all respondents indicating a lack of standardized, harmonized indicators with which policy targets can be robustly assessed across the EU.

The information obtained and the relationships created as a result of the completion of Task 8.2 has provided a strong foundation for future collaboration at the science to policy interface. WP8 will continue to use the valuable information obtained in future tasks and will continue to strengthen the science to policy interface within EJP SOIL.

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2. Introduction

Work Package 8 aims to support a strengthened science-policy interface with a strong focus on agricultural soil management and climate change mitigation and adaptation. The focus will be on providing support for the implementation of soil C accounting, the delivery of soil ecosystem services and enhanced soil quality and optimised soil management and fertilisation practices.
The key objectives are to:

- Identify and address current and future policy needs (e.g. CAP, Climate Policy, Land Degradation Neutrality) for new knowledge and scientific evidence base at a range of scales as appropriate (e.g. regional, national and European);
- Facilitate access to scientific knowledge at appropriate scales for national and European policy makers and support the effective use of scientific results for policy design at these different scales;
- Provide scientific support to policymakers to enable the design of effective policy measures at different scales, especially in relation to soil carbon accounting;
- Summarise key findings of the EJP SOIL for dissemination to policymakers;
- Promote the work and outputs of the EJP SOIL to EU and international policymakers;
- Establish relationships with related projects and initiatives in order to exploit synergies in the science-policy interface.

The approach taken in WP8 will provide evidence-based recommendations to EU and national/regional policymakers on optimal agricultural soil management through:

a) Establishing open dialogue and information flow between the EJP SOIL consortium and relevant EU and national/regional policymakers with governance over agriculture, environment and climate policy;
b) Seeking information from policymakers in order to facilitate access to, and more fully exploit scientific results that are already available for informing, developing and implementing soil related policy;
c) Synthesising research results with policy impact to policymakers to enable improved policy implementation;
d) Facilitating knowledge sharing and mutual learning among policymakers;
e) Establishing relationships with related projects and initiatives in order to exploit synergies in the science-policy interface.

The focus of EJP SOIL T8.2 - Understand & Analyse, is to gain an understanding of policymaker needs for research and soil quality indicator monitoring information, especially in the area of soil C accounting and soil ecosystem services. In this task The EJP SOIL seeks to identify and address current and future policy needs (e.g. Common Agricultural Policy, Climate Policy and European Green Deal) for new knowledge and scientific evidence base at a range of scales as appropriate (e.g. national, regional, European). These needs were identified by carrying out needs analysis surveys at the national level (Sub-Task 8.2.1 Needs Analysis) and through supporting dialogue with policymakers at national and EU levels (Sub-Task 8.2.2 Support for Dialogue on Policy Needs). T8.2 resulted in the collection and collation of important information for climate, agriculture and environmental policies that have soil targets across a range of scales and EJP SOIL participating countries.

Sub-tasks 8.2.1 and 8.2.2 were important relationship building and information gathering activities on current and future policy needs for new knowledge as well as for enhanced access to currently available scientific results. Identification of the needs surrounding both existing and emerging policies will enable WP 8 to better work towards addressing them.

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The Needs Analysis Survey Instrument (Sub-Task 8.2.1) was developed to assess the key policy stakeholder needs and comprised of four sections: A) background information, B) policy framing and barriers to implimentation of existing policy targets, C) horizon scanning for emerging policies, and D) Co-innovation, knowledge needs and requirements for implementation of emerging policies. The EU Policy Forum (Sub-Task 8.2.2) addressed policy realisations and needs and was divided into two sessions: 1) Identifying current policy ambitions and future soil aspirational goals and 2) Aligning EJP SOIL research with EU Policy Stakeholder needs and requirements for emerging and future soil policy. The National Policy forums were carried out by three countries: Ireland, Italy and Latvia. These forums were slightly modified to suit each member state but followed the same framework of the EU policy forum. The format and methodology of the Needs Analysis Instrument and the EU Policy Forum are described in detail in previous Deliverables 8.1 and 8.2 respectively

The findings and implications from the results of Sub-Tasks 8.2.1 & 8.2.2 are presented in this report, Deliverable 8.3 Summary Report on Needs Analysis. Deliverable 8.3 is structured into sections based on the three categories of needs set out in the deliverable description: 1) Priority needs as expressed by stakeholders, 2) Priority needs for new research and 3) Priority needs for enhanced access to available results and knowledge. The relevant results from Sub-Tasks 8.2.1 & 8.2.2 were sorted into the corresponding overarching sections of this report. Additionally, a fourth section was added to the report, corresponding to the data received from section D) of the Need Analysis Instrument which gathers information on emerging policies across the five EJP SOIL policy domains: 1. Climate change mitigation, 2. Climate change adaptation, 3. Avoiding land degradation, 4. Ecosystem services and 5. Food Security.

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3. Methods

3.1 EU Policy Forum

The EJP SOIL EU Policy Forum held on 28th January 2021 sought to strengthen evidence based policy formulation across Europe. It facilitated a conversation on policymaker needs and the exchange of experiences, challenges, ideas and best practices on science to policy interaction. It addressed policy realisations and needs under the current policy framework, as well as needs to realise emerging policies and future horizon scanning of policies towards 2050. The reoccurring needs and themes identified throughout this forum and the resulting implications are presented in this report.

The workshop was held virtually via ZOOM meeting platform, and involved discussions as well as interactive activities on platforms such as MentiMeter and Mural. Session 1 aimed to identify the aspirational goals related to soil challenges and current soil related policy at EU level and related policy needs and Session 2 aimed to identify emerging and future soil policy needs and requirements.

The list of participants and their corresponding organisations are presented below.

Yusuf Yigini	Food and Agriculture Organisation of the UN
Suzie Lukacova	Milieu
Rainer Baritz	European Environment Agency
Petra Manderscheid	JPI Climate
Niall Curley	European Landowner's Organisation
Nenad Peric	COP-A – COGE-CA
Maria Jose Amaral	European Commission/ REA
Leanne Roche	European Commission
Kerstin Rosenow	European Commission
Christine Muller	European Commission
Annette Schneegans	European Commission
Annabelle Williams	RISE Foundation
Alina Syp	Institute of Soil Science Plant Cultivation
Svetlana Chovancova	European Commission DG Environment
Ronald Vargas	Food and Agriculture Organisation
Ralph Bodle	Ecologic Institute
Pilar Vizcaino	European Commission / REA
Peter De Ruiter	University of Amsterdam
Nicola Di Virgilio	European Commission DG Agriculture and Rural Development
Mariana Debemardini	CEJA
Luca Montanarella	European Commission
Hinke De Groot	Permanent Representation of the Netherlands to the EU
Arwyn Jones	European Commission Joint Research Centre
Delphine Dupeux	European Landowners' Organisation
Anna Luise	UNCCD – CST
Mustafa Yurtoglu	UNCCD
Paul Luu	4 per 1000

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3.2 National Policy Forums

These forums were held at a national level in three member states, Ireland, Italy & Latvia, where key policy stakeholders were engaged to discuss emerging policies (e.g. Common Agriculture Policy, European Green Deal, Farm to Fork and Biodiversity Strategy) and the relevant gaps and needs specific to their country across the EJP SOIL policy domains of Climate change mitigation, Climate change adaptation, Avoiding land degradation, Ecosystem services and Food security.

The findings from the Irish, Italian and Latvian forums were summarized and integrated into this report.

Table 1 Brief description of the stakeholder areas of interest and number of participants at each national forum.

Country	No. of Participant Stakeholders	Stakeholder Areas of Interest
Ireland	10	CAP, Nitrates, Biodiversity, Agriculture, Peat soils, Forestry, Management strategies, Soil science, Agriculture, Climate, Ecosystem services
Italy	38	Soil science, Soil mapping, Agriculture, Agro-environment climate policy, Tourism and agriculture, Ecosystem services, Agricultural economics
Latvia	13	Rural development, Agriculture, Soil science, Rural support, Farmer's Association, Nature Conservation, Climate

3.3 Needs Analysis Survey Instrument

Thirteen EJP SOIL partner countries indicated that they would participate in Task 8.2. Responses for Sub-Task 8.2.1 Needs Analysis were received from twelve EJP SOIL partners. In each of the twelve member states, the aim was to engage with a minimum of five key policy stakeholders across the five EJP SOIL policy domains. Each key policy stakeholder completed the Policy Stakeholder Needs Survey Instrument (D 8.1) which comprised of four sections: A) background information, B) policy framing and barriers to implimentation of existing policy targets, C) horizon scanning for emerging policies, and D) Co-innovation, knowledge needs and requirements for implementation of emerging policies. These sections collected the policy needs information related to each of the five EJP SOIL policy domains: 1. Climate change mitigation, 2. Climate change adaptation, 3. Avoiding land degradation, 4. Ecosystem services and 5. Food Security.

For reporting the responses, each participating EJP SOIL partner collated and returned the survey results /report to the WP8 team using a secure centralised document storage system.

The countries that responded resulted in some geographical bias towards the northern and central zones of Europe in the contributing data and needs specified (Table 1). This should be kept in mind throughout this report, as the summary data is reflective of the northern regions of Europe and not necessarily Europe as a whole.

Table 2 List of countries that submitted responses and the climatic zones they belong to based on the classification of Metzger et al. 2005

Country	North/South Designation	Climatic Zone
Austria	North	Alpine South / Continental
Belgium	North	Atlantic Central
Denmark	North	Atlantic North
France	North/South	Atlantic Central/ Lusitanian
Germany	North	Atlantic North/ Continental
Ireland	North	Atlantic North/ Atlantic Central
Italy	South	Mediterranean Mountains/Mediterranean North
Latvia	North	Nemoral / Boreal
Netherlands	North	Atlantic North/ Atlantic Central
Poland	North	Continental
Switzerland	North	Continental / Alpine South
UK	North	Atlantic North/ Atlantic Central

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4. Report

4.1 Priority information, research synthesis and knowledge needs expressed by different policy stakeholders

4.1.1 Priority information and knowledge needs expressed at the EU Forum

The figure below (Fig. 1) highlights some of the priority information and knowledge needs expressed by the stakeholders about the emerging policies and targets discussed during the EU Policy Forum.

The need to/for:

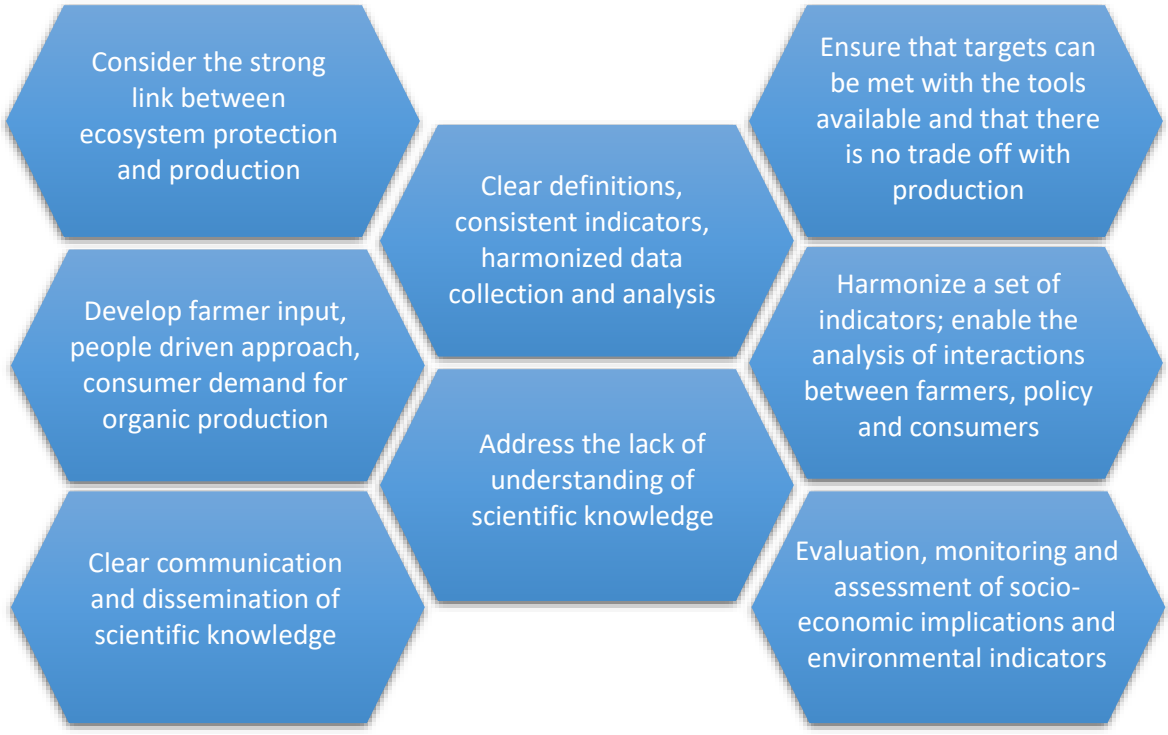

Figure 1 Infographic of some of the priority needs expressed by multiple stakeholders during the EU forum.

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4.1.2 Priority information and knowledge needs expressed at the National Forums

Ireland

Stakeholders discussed needs in the specific areas of 1. Implementation/ Adoption, 2. Monitoring/Evaluating/Reporting, 3. Trade-offs and 4. Scientific & Data needs with respect to five emerging policies. The policies considered were 1. Climate Action Plan, 2. Common Agriculture Policy, 3. Green Deal, 4. Farm to Fork and 5. Biodiversity Strategy. The needs relevant to this section of the report are listed below.

Climate Action Plan

- No baseline or long term monitoring for C stock
- Harmonization of data between projects
- Identification of areas/ lands that are C sequestering/ C emitting

Monitoring/ Evaluating/Reporting

- Long term monitoring
- Analysis at farm level

Scientific & Data Needs

- Tools that can adapt to new knowledge/ data and the level of mitigation/effectiveness they will deliver
- Soil analysis of OM, moisture level etc. at national and farm level

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Common Agriculture Policy

- Detailed reports/ up to date information on management practices and activities
- Definitions for C rich soil / parcel
- Index for Organic Matter
- Integrating mapping capabilities & activity data

Scientific & Data Needs

- Need for baseline, consolidation of all soil data
- Understanding changes in soil C & C fluxes as a result of management practices
- Data for Irish soils, local level data

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Green Deal

- No baseline, inventory or accredited scheme and thus no trading
- Enough drivers present for trading without an inventory, changes as a result of trading are key
- Agriculture needs its credits to offset its own emissions

Implementation/ Adoption

- Increase afforestation

Trade-offs

- Accountability within trading system
- Mindful approach to targets to avoid unintended consequences

Scientific & Data Needs

- Establish baseline information
- Cross sector engagement from industry to agriculture
- Regional/local data

Farm to Fork

- Unrealistic targets, require customization for each MS
- Issues of organic farming- inspections, paperwork,certification fees
- Data to support decision making, education

Trade-offs

- Overlapping synergies with water quality & biodiversity
- Less competitive agriculture in EU could mean financial loss for Ireland

Monitoring/ Evaluating/ Reporting

- Targeted efforts required at farm level to ensure profitability
- Continued supporting evidence of measures
- Mindful approach to targets to avoid unintended consequences

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Biodiversity Strategy

- Healthy soil is the key link between this policy and farm to fork

Implementation/ Adoption

- Knowledge tools to bridge the gap: educate farmers & public
- Value needs to be assigned to habitats/ non-productive areas

Trade-offs

- Loss/ reduction of production
- Positive trade-offs with climate change & water quality

Monitoring/ Evaluating/ Reporting

- Biodiversity consensus
- Baseline data

Scientific & Data Needs

- Value, indicies, functions of soil biodiversity
- Management practices that improve soil biodiversity

- Need for data analysis & implementation at all scales and levels, Farmer to National
- Need for a bottom up approach that includes, educates and considers farmers
- Need for increased synergy between policies and agencies
- Need for long term thinking to avoid negative repercussions of meeting current targets

Box 1 Priority needs expressed by stakeholders during Irish national forum

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Italy

Stakeholders discussed needs specific to their country within the five EJP SOIL policy domains. The needs relevant to this section of the report are listed below.

Climate Chnage Mitigation

- Integrate legislation to avoid soil consumption (e.g. law on nuclear waste that ends up on agricultural soils instead of unused areas)
- Need for operating systems
- Supporting C sink

Climate Change Adaptation

- There is still too little awareness, in the productive sector, on the ecosystem functions of agricultural activity
- Need for operating systems

Food Security

- Quantification & codification of objectives to be used in policies (RDPs, incentives)
- Soil protection directive at EU level

Ecosystem Services

- Need to define a dedicated legal framework on soil

Avoiding Land Degradation

- Foresee a law on land consumption
- Integration with energy policies (considering land consumption from photovolataic on the ground)
- Definition of specific measures
- Improve control on the ground by identifying critical situations
- Favour the cultivation of permenant crops and improvement crops in hills
- Monitoring

- Increased legislative support
- Increased awareness of critical issues relating to soil
- Clarification and definition of policy intents and targets
- Increased collaboration and sharing of data at a national level

Box 2 Priority needs expressed by stakeholders during the Italian national forum

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Latvia

During the Latvian national forum, key targets within emerging policies were identified as highly relevant to this member state and were discussed in depth. For each target needs within the following aspects were considered: Knowledge needs, Implementation mechanisms, Monitoring methods and Indicators. The needs relevant to this section of the report are listed below.

Green Deal - Reduction of greenhouse gases to zero net emissions by 2050

Knowledge Needs

- Increased knowledge of the calculation and reduction of emissions
- Country specific approach to assess and understand the current situation and impacts in Latvia
- Clear, reliabale, understandable information for farmers and end users

Implementation Mechanisms

- Transfer of knowledge from institutes and scientists to farmers, enouraging close cooperation
- Electronic platforms at farm level shoudl be introduced to help farmers track the impact of their farms and farming methods on GHG emissions

Monitoring Methods

- Electronic tools should be introduced which are capable of accounting for and presenting in practice the amount of carbon emitted and sequestered by each farmer
- Coallation of data from individual farmers to create a database for national monitoring

CAP - Reducing nutrient loss without reducing soil fertility

Knowledge Needs

- Increased knowledge of soil fertility, health and quality including comparing the current situation in Latvia with other EU countires and integrating international experiences
- Knowledge transfer to farmers about the release of nutrients from the soil, the factors that affect it and the role of soil in nutrient retention
- Further research and training on the different methods of organic farming

Implementation Mechanisms

- Measures with specific objectives in combination with feasability studies
- Combined common agricultural measures that can be understood and accessed by farmers

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Farm to Fork - Transition from conventional to organic farming (25% of agricultural land transformed by 2030)

Knowledge Needs

- Increased knowledge of Actions to support the transition such as the reevaluation of the existing market and ensuring equal competition
- Education of farmers an ensuring scientific support on the economic situation and solutions to prevent loss of income with a change in famring methods
- Research and evaluation of the situation regarding biological and permenant grassland and their role in the emission balance

Implementation Mechanisms

- To ensure a successful transition to organic farms, maket adjustment through market promotion programmes is necessary.

Monitoring Methods

- Inclusion of organic farming inthe national monitoring programme

Indicators

- Define organic land at a nationl level, at present a large proportion of backyard farms that do not receive aid payments are essentially organic farms

Farm to Fork - Reduction in the use of chemical and hazardous pesticides by 2030

Knowledge Needs

- Increased knowledge of pesticide alternatives
- Increased number of studies relating to the doses of the pesticides already used and their environmental impacts
- Ensure that the withdrawal of existing chemicals and the introduction of new alternatives is carefully asssessed to ensure limited economic effects on the market and farmers

Implementation Mechanisms

- More important to ensure a uniform framework for the use of permissible quantities of pesticides, but not a uniform framework for the reduction
- Decison making tools should be developed that combine different datasets adn consider the spread of diseases, climate, fertilisation etc. to provide apprpriate recommendations for farmers

Monitoring Methods

- Soil monitoring at both the farm and national level must be ensured by providing a long term data collection system

Indicators

- An information system on the use of pesticides should be put in place at the national level.

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Biodiversity Strategy - Limiting soil biodiversity loss

Knowledge Needs

- Educate farmers on the topic of soil biodiversity and how to increase and preserve biodiversity int he landscape
- Increased knowledge on soil organic matter content and changes over time
- Clearly define various landscape elements, their function and assign the appropriate value to them

Implementation Mechanisms

- Financial support to enable farmers to use bio-preperations and compost
- Promotion of direct sowing, education on these practices
- Aid payments for the conservation and introduction of naturla buffer zones

Monitoring Methods

- Division of farming systems into blocks (e.g. arable land, orchard, ditch) and biodiversity should then be defined for each type of block based on the parameters applied

- Increased knowledge transfer and communication with farmers on best practices and techniques
- Increased financial support for farmers to implement new management practices
- Greater clarification of national level policies and monitoring systems
- Increased cooperation between areas of science, policy and farmers

Box 3 Priority needs expressed by stakeholders during the Latvian national forum

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4.1.3 Priority information and knowledge needs expressed in the Needs Analysis Survey Responses

In this section responses from Section B 'Barriers to Implementation' of the Needs Analysis Survey Instrument described in Deliverable 8.1 were used to identify the priority information and knowledge needs surrounding gaps in policy realisation and the barriers that contribute to those gaps. Each member state was asked to identify existing policies specifically relevant to them, the corresponding soil challenges and the barriers that contribute to the gaps in policy realisation.

In cases where only the policy was identified by the member state (Ireland, Latvia, UK), the corresponding soil challenges were assigned by the authors based on the content of the policies identified and after consultation with the contributors from the member states. The breakdown of which policy was assigned to its corresponding soil challenge can be found in the Appendix (Table 62).

In other cases, member states (Germany & Switzerland) identified several soil specific targets that were associated with multiple soil challenges. To avoid doubling of data relevant soil targets were only used once. The selection of the targets for the respective soil challenges was done via consultation with the correspondents from the relevant member states and is available in the Appendix (Table 63). The appendix also contains information on those targets that were identified but not used in the graphs (Table 64).

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Austria

All of the soil challenges were considered by this member state as well as the policies relevant to them. Generally, there was a moderate gap in policy target realisation for the majority of soil challenges (Table 3).

Table 3 Key soil challenges and the associated policies identified by Austria as having gaps between policy targets and realisation of those targets using a Likert scale where 1 represents a very large gap and 5 represents no gap. (SOC- soil organic carbon, OPUL – Rural development Programme, FUNC – Austrian Standard OENORM, NAP – Nitrate Action Plan)

Policies	Soil Challenges	Gap Rating
Soil Protection Act ÖPUL ,FUNC	Maintain/ Increase SOC	3
ÖPUL, NAP	Avoid N2O, CH4 emissions	3
Soil Protection Protocol	Avoid peat degradation	4
Soil Protection Act Soil Protection Protocol NAP, ÖPUL	Avoid soil erosion	2.5
Soil Protection Protocol FUNC	Avoid soil sealing	2
	Avoid salinization	3
Soil Protection Act Soil Protection Protocol FUNC	Avoid acidification	3
Soil Protection Protocol Soil Protection Act Sustainability Law NAP, FUNC	Avoid contamination	4
Soil Protection Act Soil Protection Protocol NAP, FUNC	Optimal Soil Structure	3
FUNC	Enhance soil biodiversity	2.5
Soil Protection Act NAP, ÖPUL, FUNC	Enhanced soil nutrient retention/ use efficiency	3
FUNC	Enhance water storage capacity	3

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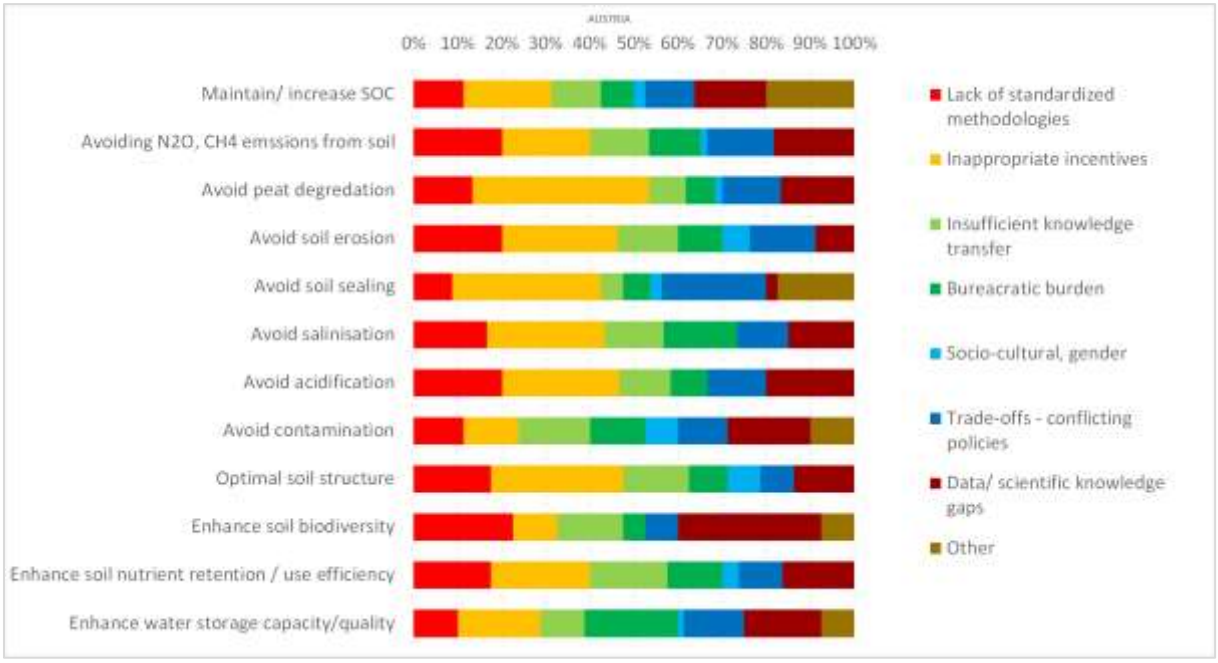

Figure 2 Average weighting, by percentage, of barriers identified by stakeholders in Austria that contribute to gaps in policy with respect to the soil challenges identified.

Inappropriate incentives is a key barrier for all soil challenges, followed closely by data/scientific knowledge gaps and a lack of standardized methods (Fig. 2). Trade-offs and insufficient knowledge transfer and are the next most prevalent barriers along with bureaucratic burden. This member state defined the "Other" category as "Lack of political will for implementation" which was viewed to act as a barrier to five of the soil challenges identified. This indicates that these challenges in particular need to be more seriously considered by politicians and policy makers.

- Appropriate incentives
- Decreased gaps in data & scientific knowledge
- Standardized methods
- Decreased trade-offs with conflicting policies

Box 4 Top four priority needs as expressed by Austria across all soil challenges

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Belgium

For the most relevant soil challenges identified for Belgium, there was generally a large gap perceived between current policy targets and realisation with the majority of ratings at a value of two (Table 4).

Table 4 Key soil challenges identified by Belgium as having gaps between policy targets and realisation of those targets using a Likert scale where 1 represents a very large gap and 5 represents no gap. (SOC- soil organic carbon)

Soil Challenges	Gap Rating
Enhance soil biodiversity	4
Enhance water storage capacity	2
Enhanced soil nutrient retention/use efficiency	2
Maintain/ increase SOC	2
Optimal soil structure	2

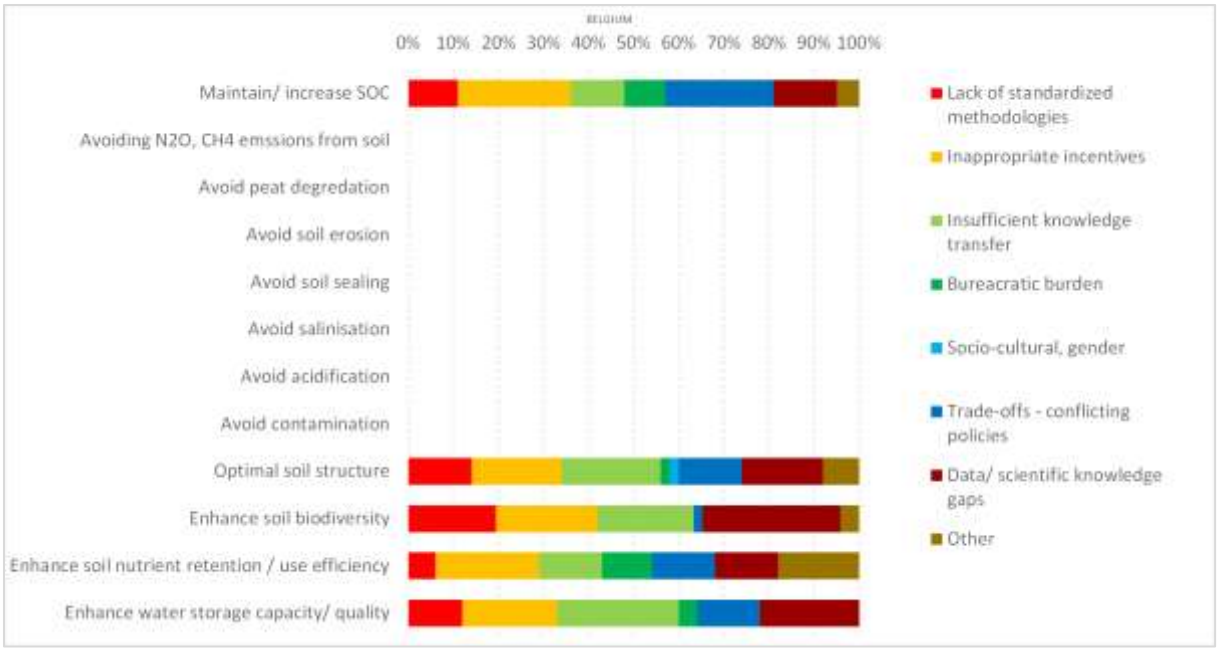

Figure 3 Average weighting, by percentage, of barriers identified by stakeholders in Belgium that contribute to gaps in policy with respect to the soil challenges identified..

The majority of barriers listed account for some fraction of the gap between policy and realisation for the identified soil challenges. Lack of standardization, inappropriate incentives, insufficient knowledge transfer, trade-offs and data/scientific knowledge gaps are the main barriers, with less emphasis on bureaucratic burden and socio-cultural, gender barriers (Fig. 3).

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Table 5 Stakeholder comments corresponding to the soil challenges identified by Belgium.

Identified Soil Challenge	Stakeholder Comments
Enhance soil biodiversity	Significant knowledge gaps about the role of organisms, appropriate indicators and using that knowledge for policy work as no specific policies/targets exist for soil biodiversity.
Enhance water storage capacity	Issues of trade-offs and conflicting policies. Need for co-creation and testing of techniques with farmers and farm specific advice. More quantitative information is needed on the link between C and water transport through soil.
Enhance soil nutrient retention/use efficiency	Strong links to market demand for crops that require higher fertilizer use, economic trade-offs of yield reduction. Need for monitoring and control of mineral fertilizer usage, need for rewards for farmers doing well not only penalties for over use.
Maintain/increase SOC	Trade-offs include hampering of increasing SOC by the manure action plan, issues with the nitrate policy. Bureaucratic burdens restrict use of organic residue streams and allow tearing of grassland to prevent status of permanent grassland. There is also a need for more information on practices and in depth knowledge of C sequestration and monitoring.
Optimal soil structure	High spatial variability and time-consuming measurements make it difficult to detect issues with soil structure. More data is needed on the economic losses/cost of a damage/decrease in soil structure. Need for standardized methods to assess soil compaction. Consideration of the links between soil structure and C, water transport through soil. Possibility to create soil structure maps using proxy variables e.g. crop growth, standing water.

- Appropriate incentives
- Decreased gaps in data & scientific knowledge
- Increased knowledge transfer
- Decreased trade-offs with conflicting policies

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Denmark

Six key soil challenges were identified in Denmark. The gaps in policy target realisation were very large to large in size across all soil challenges (Table 6).

Table 6 Soil challenges identified by Denmark as having gaps between policy targets and realisation of those targets using a Likert scale where 1 represents a very large gap and 5 represents no gap.

Soil Challenge	Gap Rating
Maintain / Increase SOC	1
Avoid N2O, CH4 emissions from soil	2
Avoid peat degradation	2
Avoid soil erosion	2
Optimal soil structure	1
Enhance soil nutrient retention/ use efficiency	2

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The method by which this member state completed this section of the survey instrument could not be used to generate a graph; instead, the data was represented in the form of Table 7.

Table 7 The relevance of the various barriers to each of the soil challenges identified by Denmark.

Barriers	Soil Challenges					
	Maintain/ Increase SOC	**Avoid N2O, CH4 emissions**	**Avoid peat degradation**	**Avoid soil erosion**	**Optimal soil structure**	**Enhance soil nutrient retention/ use efficiency**
Lack of Standardised Methods	Not Relevant	Not Relevant	Not relevant	Not Relevant	Not Relevant	Not Relevant
Inappropriate incentives	Highly relevant	Highly Relevant	Highly Relevant	Highly Relevant	Highly Relevant	Relevant
Insufficient knowledge transfer	Relevant	Relevant	Somewhat Relevant		Relevant	
Bureaucratic burden	Somewhat Relevant	Somewhat Relevant	Somewhat Relevant	Somewhat Relevant	Neutral	Neutral
Socio-cultural & gender	Relevant	Relevant	Relevant		Somewhat Relevant	Neutral
Trade-offs	Relevant	Relevant	Relevant	Relevant	Relevant	Relevant
Data and Scientific Knowledge Gaps	Relevant	Relevant	Relevant	Relevant	Relevant	Relevant
Other	Relevant	Neutral	Highly Relevant		Neutral	Highly Relevant

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Table 8 Stakeholder comments corresponding to the soil challenges identified by Denmark

Identified Soil Challenge	Stakeholder Comments
General Comments	The general problem for many of these items is that there is no obligating policy that drives the development towards policy realization at national or EU level; therefore, it is not prioritized in local policy making.
Maintain/increase SOC	Farmers report concern regarding the ongoing loss of SOC and lack good schemes to support SOC build up, such as crop rotations. Uneven distribution of livestock production is a critical issue that lead to loss of SOC instruments are needed.
Avoid peat degradation	Further land consolidation is needed to ensure that agricultural production is relocated from the low lying peatlands, including schemes for rewetting, and production systems that ensure protection against nutrient leaching if areas are rewetted
Avoid soil erosion	For the last 30 years, there has been a lack of specific research on conservation practices to avoid soil erosion in DK, therefore, the overview and knowledge basis for interventions in relation to erosion is scarce.
Enhance soil nutrient retention/use efficiency	Diffuse pollution is highly localized. There is a need for comprehensive landscape planning that exempts the most polluting areas. Nutrient management is a very controversial topic in a Danish context, and perspectives on the scientific foundation behind regulation differ. It is very difficult to find common ground and this reflects highly diverging opinions. In terms of incentives, it is not only that there is a need for an update of incentives, but also that current measures are insufficiently adopted.

- Appropriate incentives
- Decrease trade-offs with conflicting policies
- Decrease data & scientific knowledge gaps
- Increased knowledge transfer

Box 6 Priority needs as expressed by Denmark

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France

Several national policies and the corresponding soil challenges associated with them were identified to have a moderate gap to no gap between current policy and target realisation for a range of soil challenges (Table 9).

Table 9 Key policies and their related soil challenges identified by France as having gaps between policy targets and realisation of those targets using a Likert scale where 1 represents a very large gap and 5 represents no gap.

Policies	Soil Challenges	Gap Rating
Water Framework Directive	Water Quality	3
France Climate Engagement National Plan Territorial Climate and Energy Plan	Maintain/ Increase SOC	5
France Climate Engagement National Plan Territorial Climate and Energy Plan	Avoid N2O, CH4 emissions	3
National Plan for Biodiversity	Enhance soil biodiversity	5
Territorial Food Plan	Enhanced soil nutrient retention/ use efficiency	3
Land Conservation	Avoid soil erosion	3
National Policy on Wetland Conservation	Avoid peat degradation	2
National Plan for Biodiversity Territorial Food Plan	Avoid soil sealing	5

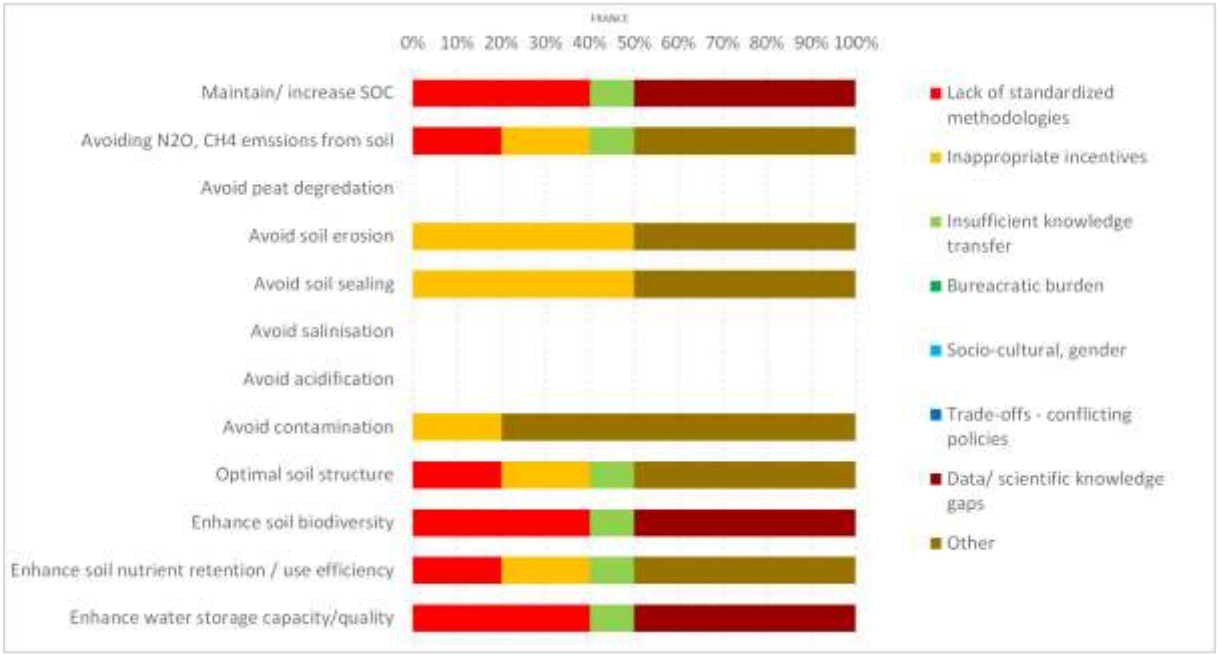

Figure 4 Average weighting, by percentage, of barriers identified by stakeholders in France that contribute to gaps in policy with respect to the soil challenges identified.

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For the five of the nine soil challenges considered relevant, at least 50% of barriers to their realisation were identified as 'Other' and the specific barrier differed depending on the soil challenge (Fig. 4). Under the soil challenges of water quality and avoiding emissions, this category was defined as "Structural difficulties: Too high animal density in some regions". Under the challenges of avoiding soil erosion and contamination, this category was defined as "not really included in policy". The other main barriers were lack of standardized methods, inappropriate incentives, data / scientific knowledge gaps and to a lesser extent insufficient knowledge transfer. The barriers of bureaucratic burden, socio-cultural and gender and trade-offs with other policies were not identified as contributing to the gaps in policy realisation for this member state.

- Other (defined on a challenge specific basis)
- Appropriate incentives
- Standardized methods
- Decreased gaps in data & scientific knowledge

Box 7 Top four priority needs as expressed by France across all soil challenges

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Germany

This member state has a great deal of policies already in place which provide guidance on soil specific targets. Most policies and targets however, were found to have large to moderate gaps between them and their realisation, with the majority of gap ratings ranging from 1 to 3 (Table 10).

Table 10 Key policies and their related soil challenges identified by Germany as having gaps between policy targets and realisation of those targets using a Likert scale where 1 represents a very large gap and 5 represents no gap.

Policies	Soil Targets	Gap Rating
German Federal Soil Protection Law	Preserved typical humus content	2
German Federal Soil Protection Law German Strategy for Adaptation to Climate Change	Code of good practice is applied	2
German Strategy for Adaptation to Climate Change	Networks to record soil, water and air quality	3
	Climate impact monitoring	3
	Investment in sustainable agriculture, including research and advice	2.5
	Dialogue and knowledge transfer with experts	2.5
	Achieve concepts to regenerate wetlands and stabilize hydrological conditions in peats and bogs	3.5
Fertilizer Application Ordinance	Ex-ante determination of nutrients in soil and in fertilizers	3
	Amount of organic fertilizer limited	4
Climate Protection Programme	Development of grassland strategy	1
	Voluntary certification of humus farming	2
	No-debit in LULUCF-sector	3
Climate Protection Programme German Sustainable Development Strategy	Increase organic farming	3
	GHG emissions reduced	2
	Reduction of Nitrogen surplus to 70 kg/ha	3
Climate Protection Programme German Sustainable Development Strategy Discussion paper crop production strategy	Reduce sealing to < 30 ha/day	1.5
Discussion paper crop production strategy	Development or updating of decision support tools, including digital technology	2.5
	Steady state of humus on all arable soils by 2030	2
	Regional biodiversity targets set	1.5
	End use of glyphosphate	2
German Sustainable Development Strategy Discussion paper crop production strategy	Establish soil protection indicator	3
	50 mg/l nitrate in groundwater not exceeded	2

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Discussion paper crop production strategy German Strategy for Adaptation to Climate Change	Establish soil erosion register, monitor erosion	2
German Sustainable Development Strategy	Involvement of social actors	1
	Biodiversity index increased to 100	1.5
	Eutrophication decreased by 35%	2

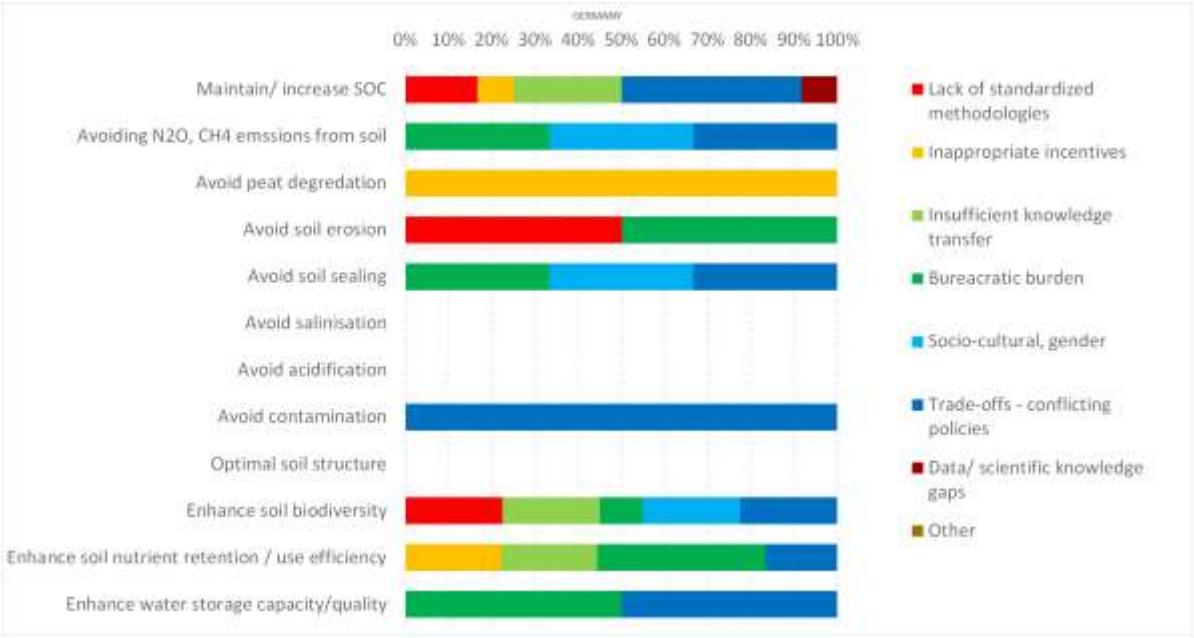

Figure 5 Average weighting, by percentage, of barriers identified by stakeholders in Germany to the achievement of multiple soil targets grouped under allocated soil challenges. Allocation soil targets to soil challenges is described in the Appendix (Table 63).

For the majority of soil challenges only two to five barriers, out of the eight possible options, were perceived to contribute to the gaps in realisation for any one soil challenge (Fig.5). In one case, inappropriate incentives were identified as the sole barrier associated with the soil challenge of avoiding peat degradation. In another, trade-offs with conflicting policies was identified as the sole barrier associated with the soil challenge of avoiding contamination. Bureaucratic burden, trade-offs with conflicting policies and insufficient knowledge transfer were the most prevalent barriers followed by lack of standardized methods and socio-cultural & gender barriers.

- Decreased trade-offs with conflicting policies
- Decreased bureaucratic burden
- Appropriate incentives
- Standardized methods

Box 8 Top four priority needs as expressed by Germany across all soil challenges

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Ireland

This member state identified six policies, which were most relevant to them, covering a range of soil challenges. The gaps identified between policy targets and their realisation ranged from large to small based on the responses given (Table 11).

Table 11 *Key policies identified by Ireland as having gaps between policy targets and realisation of those targets using a Likert scale where 1 represents a very large gap and 5 represents no gap. (GAP – Good Agricultural Practice for protection of waters, POM – Programme of measures, SMR- Statutory management requirements, GAEC – Good agricultural and environmental conditions, EFA – Ecological focus areas)*

Policies	Gap Rating
Nitrates GAP POM Nutrient Management	3
Cross Compliance SMR GAEC	4
Climate Action Plan	2
Biodiversity Action Plan 2017-2021	2
Environmental Impact Assessment Act	5
Direct Payments (EFA, Greening, Crop Diversification)	4

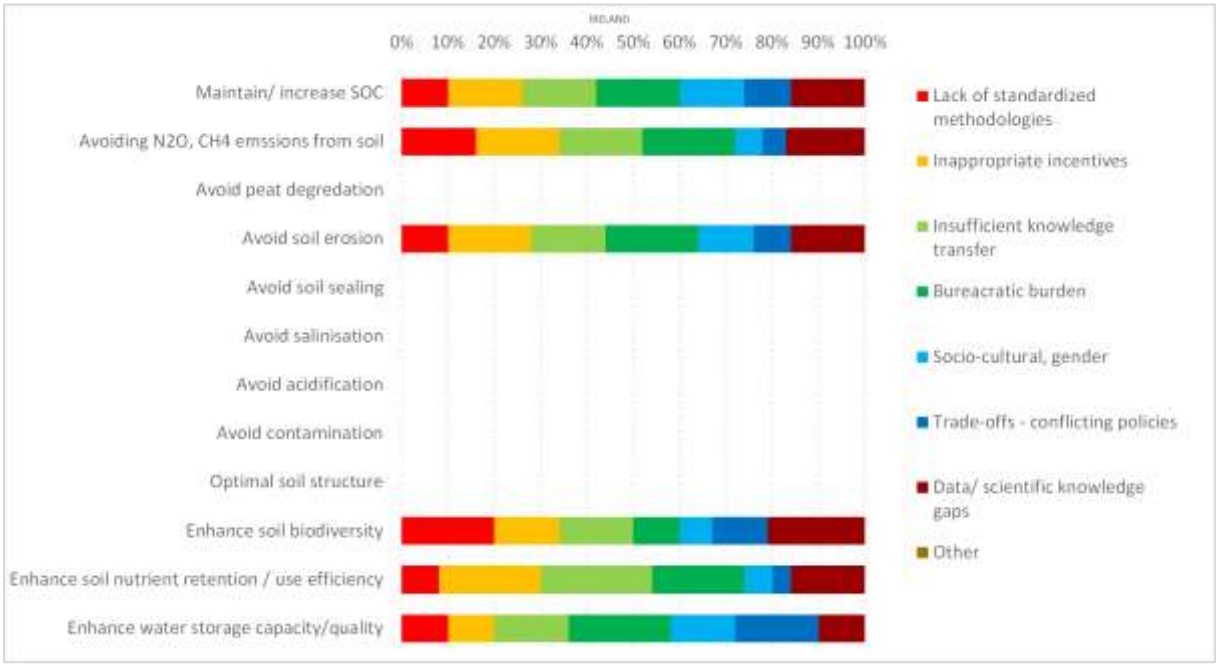

Figure 6 Average weighting, by percentage, of barriers identified by stakeholders in Ireland that contribute to gaps in policy with respect to the soil challenges allocated. Method of allocation of soil challenges to identified policies can be found in the Appendix (Table 62).

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Among the soil challenges identified, bureaucratic burden and insufficient knowledge transfer were the most significant barriers followed closely by inappropriate incentives and data/ scientific knowledge gaps (Fig. 6). Barriers resulting from a lack of standardized methods, trade-offs with other policies and socio-cultural/ gender were less heavily weighted among all soil challenges. This suggests a need for reduced bureaucratic burden associated with policy implementation as well as greater focus on new research and on the transfer of new scientific knowledge to the public and other end users.

Table 12 Stakeholder comments corresponding to the policies identified by Ireland

Stakeholder Identified Policy	Stakeholder Comments
Nitrates GAP & POM nutrient management	Lack of scientific data linking nutrient losses from agricultural soils (soil type specific) under different managements to the water bodies (water quality) prevents localised measures from being implemented
Cross compliance SMR & GAEC	Better knowledge transfer to farmers on the benefits for implementing measures
Climate Action Plan	Need science to inform Carbon sequestration potentials for different soils and management systems. Need robust indicators to account for changes in C stocks
Biodiversity Action Plan	On soils lack of indicators to benchmark quality. Highly heterogeneous soils across farms and regions make it difficult to standardise
Environmental Impact Assessment Act	Trade-offs between drainage of organic soils and carbon losses, benefits on managed mineral soils (i.e. those receiving N) to reduce seasonal N2O emissions
Direct Payments (EFA, Greening, Crop Diversification)	Slow practice adoption of measures on farms needs further incentivisation and advisory support

- Decreased bureaucratic burden
- Increased knowledge transfer
- Appropriate incentives
- Decreased gaps in data & scientific knowledge

Box 9 Top four priority needs as expressed by Ireland across all soil challenges

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Italy

The national forum conducted by this member state resulted in the ranking of soil challenges based on their level of priority. Engagement with stakeholders also identified the gaps that limit policy realisation with respect to these soil challenges. Responses were aggregated and the results indicate that the gaps in policy target realisation are very large to moderate in size (Table 13).

Table 13 Soil challenges ranked in order of priority, from greatest to least, by stakeholders during the Italian national forum and the average rating of the gaps between policy targets and realisation of those targets using a Likert scale where 1 represents a very large gap and 5 represents no gap.

Increasing priority

Soil Challenges	Gap Rating
Preserving/ Enhancing SOM content	2.1
Avoid soil erosion	1.9
Avoid soil sealing	1.7
Enhance nutrient retention and use efficiency	2.4
Enhancing soil water storage capacity	2.2
Avoid N2O, CH4 emissions from soil	2.6

While the various barriers were not weighted based on their contribution to the identified gaps, discussions with stakeholders served to identify the barriers most relevant to the soil challenges identified and they are listed below in Table 14.

Table 14 Stakeholder comments corresponding to the soil challenges identified by Italy

Stakeholder Identified Soil Challenge	Stakeholder Comments
Preserve/ Enhance SOM	Inappropriate soil management practices Lack of scientific knowledge on the linkage between SOM and many other soil functions
Avoiding soil erosion	In depth understanding of severe erosive phenomena which affects a high percentage of utilized agricultural area in Italy. Hilly landscape is especially prone to soil erosion. Problem has been overlooked by both national policies and the wider public.

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Avoiding soil sealing	Lack of adequate consideration on the trade-off of various policies e.g. spreading of renewable energies; expansion of urban areas) on land consumption: need for a cross cutting policy perspective. No dedicated legislation for protection against soil consumption
Enhancing soil water storage capacity	Deeply linked to other complex soil processes
Avoid N2O, CH4 emissions from soil	Room for improvement and better implementation of operational guidelines and recommendations for types of tillage/ adopted management practices that are key to keeping emissions low.

- Decreased gaps in data & scientific knowledge
- Increased knowledge transfer
- Decreased trade-offs with conflicting policies
- Appropriate incentives

Box 10 Priority needs as expressed by Italy

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Latvia

Four key policies were identified by this member state, all of which were found to have large gaps between policy targets and realisation with ratings of 2.4 to 2.6 across the four policies (Table 15).

Table 15 Key policies identified by Latvia as having gaps between policy targets and realisation of those targets using a Likert scale where 1 represents a very large gap and 5 represents no gap.

Policies	Gap Rating
Rural Development Program 2014 – 2020	2.6
Environmental Policy Guidelines 2014 – 2020	2.4
National Energy and Climate Plan of Latvia 2021 – 2030	2.6
Strategy of Latvia for reaching climate neutrality until 2050	2.6

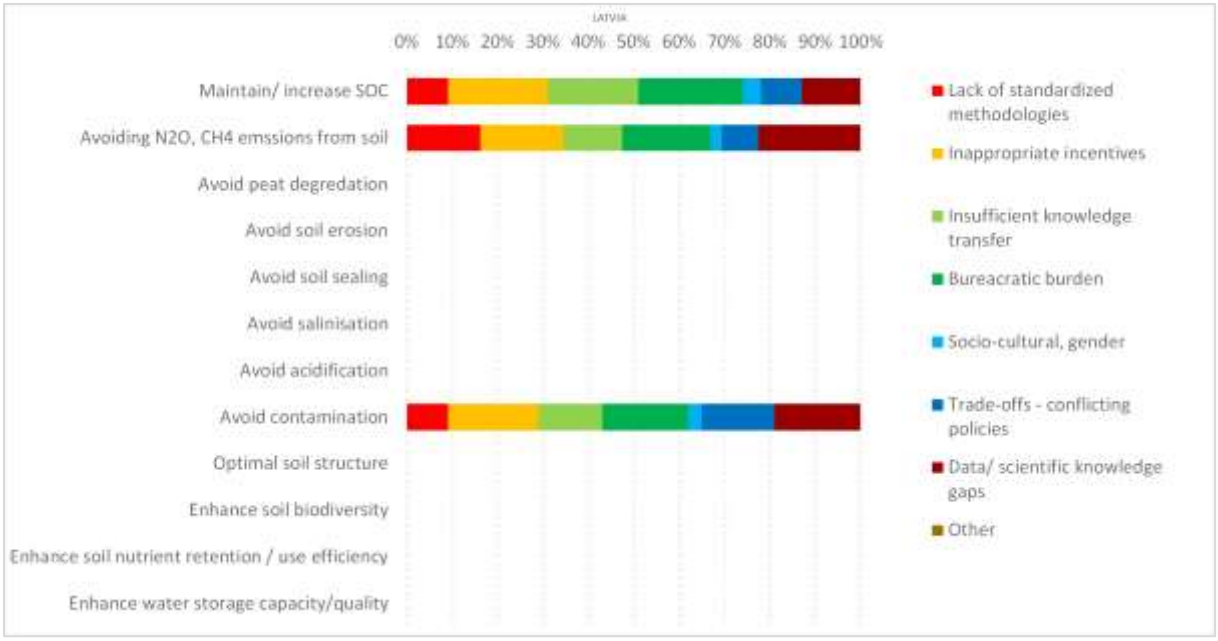

Figure Average weighting, by percentage, of barriers identified by stakeholders in Latvia that contribute to gaps in policy with respect to the soil challenges allocated. Method of allocation of soil challenges to identified policies can be found in the Appendix (Table 62).

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All barriers were found to contribute to the relevant soil challenges, the distribution of the weighting is fairly consistent across all barriers with only slight shifts for each soil challenge. Data/ scientific knowledge gaps, bureaucratic burden and inappropriate incentives were slightly more weighted than insufficient knowledge transfer and lack of standardized methods (Fig. 7). Trade-offs and socio-cultural & gender barriers were weighted lowest.

- Decreased bureaucratic burden
- Appropriate incentives
- Decreased gaps in data & scientific knowledge
- Increased knowledge transfer

Box 11 Top four priority needs as expressed by Latvia across all soil challenges

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Netherlands

Four key policies were identified by this member state relating to six key soil challenges. The gaps present in the realisation of these policy targets were found to be moderate in nature for all policies and challenges considered (Table 16).

Table 16 Key policies and the associated soil challenges identified by the Netherlands as having gaps between policy targets and realisation of those targets using a Likert scale where 1 represents a very large gap and 5 represents no gap.

Policies	Soil Challenges	Gap Rating
Dutch Soil Strategy Climate Policy	Maintain/ Increase SOC Avoid N_2O, CH_4 emissions Avoid peat degradation	3
CAP		3
Kringlooplandbouw Deltaplan biodiversiteitsherstel	Enhance soil biodiversity	3
Green Deal	Enhanced soil nutrient retention/ use efficiency	3
CAP	Optimal soil structure	3

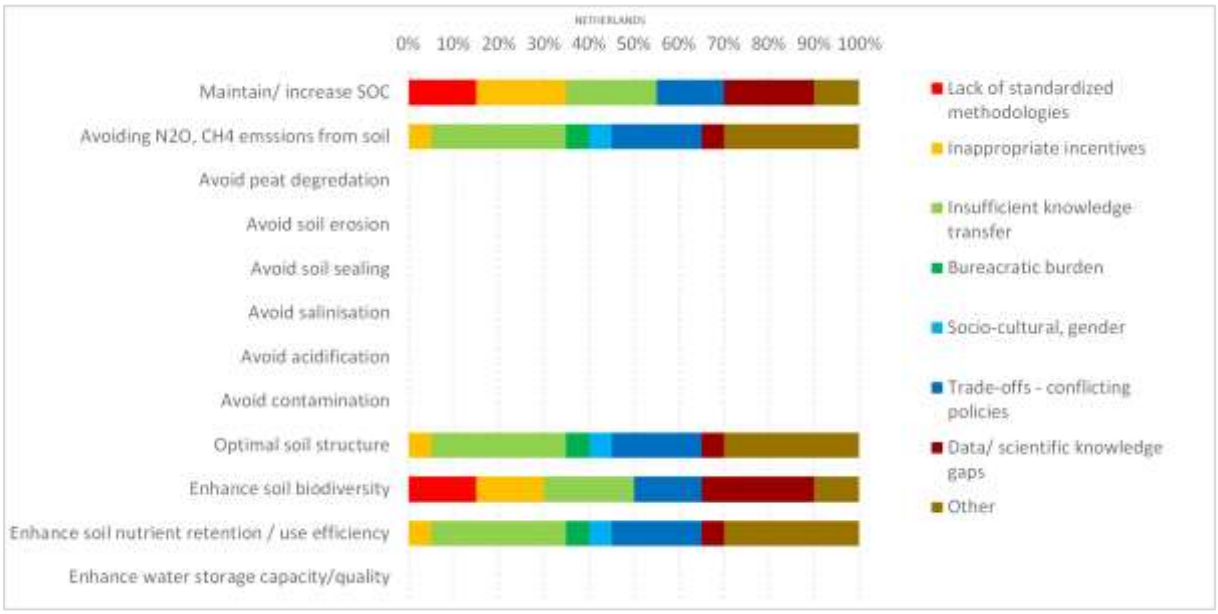

Figure 7 Average weighting, by percentage, of barriers identified by stakeholders in the Netherlands that contribute to gaps in policy with respect to the soil challenges identified.

This member state defined the "Other" category as "Behaviour + Policy", indicating the importance of understanding farmers' behaviour in reaching policy goals, which accounted for a significant portion

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of the barriers for three of the five soil challenges considered (Fig. 8). Other heavily weighted barriers included insufficient knowledge transfer and trade-offs with other policies. Gaps in data/ scientific knowledge also contributed as a barrier as well as a lack of standardised methods and inappropriate incentives to a much lesser extent along with bureaucratic burden and socio-cultural and gender barriers. Indicating a greater need for exchange of knowledge and a shift in the perception of policy as well as a reduction in the conflicts between policies.

- Increased knowledge transfer
- Changed behaviour towards policy
- Decreased trade-offs with conflicting policies
- Decreased gaps in data & scientific knowledge

Box 12 Top four priority needs as expressed by the Netherlands across all soil challenges

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Poland

All twelve soil challenges were considered relevant to this member state, and were associated with corresponding policies. Overall, the gaps in policy realisation were rated large to moderate for the majority of soil challenges. Two challenges were perceived to have small gaps in policy realisation: avoid soil sealing and avoid soil acidification (Table 17).

Table 17 Key policies and the associated soil challenges identified by Poland as having gaps between policy targets and realisation of those targets using a Likert scale where 1 represents a very large gap and 5 represents no gap.

Policies	Soil Challenges	Gap Rating
Good Agricultural and Environmental Conditions (GAEC); The Sewage Sludge Directive (SSD)	Maintain/increase SOC	2
"Water Framework Directive"	Enhance water storage capacity	2
EU Biodiversity Strategy for 2030; The Habitats Directive	Enhance soil biodiversity	2
Good Agricultural and Environmental Conditions (GAEC)	Enhanced soil nutrient retention/use efficiency	3
Greening measures, Cross-compliance and Rural Development Policy under CAP	Avoid soil erosion	3
Good Agricultural and Environmental Conditions (GAEC), Agri-Environment-Climate Measures (AECMs)	Optimal soil structure	3
Nitrate Directive	Avoid N2O, CH4 emissions	2
Water Framework Directive; Nature Directive"	Avoid soil sealing	4
The Sustainable Use of Pesticides Directive (SUPD)	Avoid contamination	2
Habitat Directive	Avoid peat degradation	3
Law on fertilizers; Nitrate Directive	Avoid acidification	4
Fertilizers Directive	Avoid salinization	3

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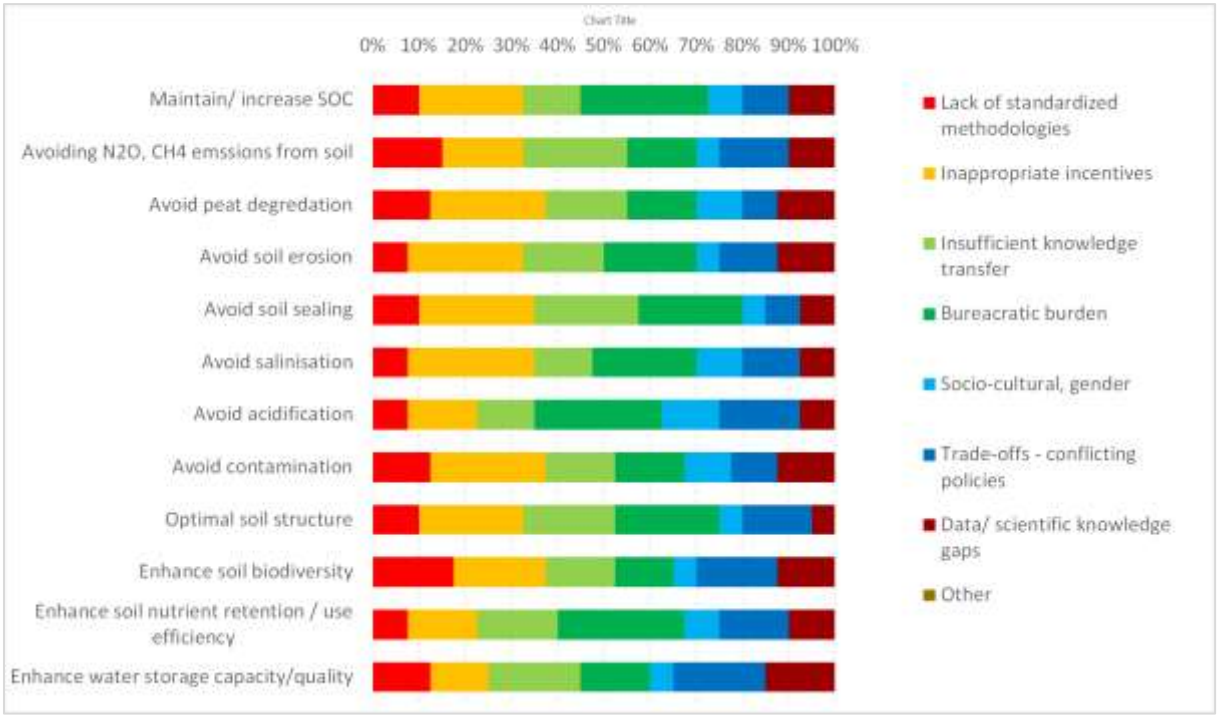

Figure 8 Average weighting, by percentage, of barriers identified by stakeholders in Poland that contribute to gaps in policy with respect to the soil challenges identified.

All identified barriers contributed to the gaps in each soil challenge. Inappropriate incentives and bureaucratic burden were the most heavily weighted, followed by insufficient knowledge transfer and trade-offs with conflicting policies (Fig. 9). Lack of standardised methods, data / scientific knowledge gaps and socio-cultural, gender barriers were rated much lower.

- Appropriate incentives
- Decreased bureaucratic burden
- Increased knowledge transfer
- Decreased trade-offs with conflicting policies

Box 13 Top four priority needs as expressed by Poland across all soil challenges

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Switzerland

Although not an EU member state, this country identified several soil challenges within their own national policies which were all rated to have moderate to very large gaps between the targets and their realisation (Table 18).

Table 18 Key policies and the associated soil targets identified by Switzerland as having gaps between policy targets and realisation of those targets using a Likert scale where 1 represents a very large gap and 5 represents no gap.

Policies	Soil Target	Gap Rating
Soil Strategy Switzerland	Avoidance of permanent compaction in agricultural soils	1
	No permanent impairment of soil functions through erosion on agricultural land	2
	No impairment of water bodies and semi-natural habitats by washed-away soil material from agricultural areas	3
	Compensation of soil organic matter losses due to agricultural use of mineral soils	2
	Minimizing the loss of soil organic matter due to agricultural use of organic soils	1
	No permanent impairment of soil functions, water and natural habitats by pollutants from agriculture	2
	Substantial reduction of risks to humans, animals, plants and water bodies by pesticides, fertilizers and other agricultural inputs	3
	No permanent loss of soil biodiversity and activity due to agricultural soil use	2
Environmental Goals Agriculture	No impairment of soil fertility and [human] health due to inorganic or organic contaminants from agriculture	4
	Input of individual contaminants from agriculture in soils is smaller than their output and degradation	3
	Erosion on agricultural soils has to stay below threshold and prevention of talweg erosion	3
	No impairment of soil fertility through erosion	3
	No impairments of water bodies by washed-away soil material from agricultural soils	4
	Avoiding permanent compaction of agricultural soils	3

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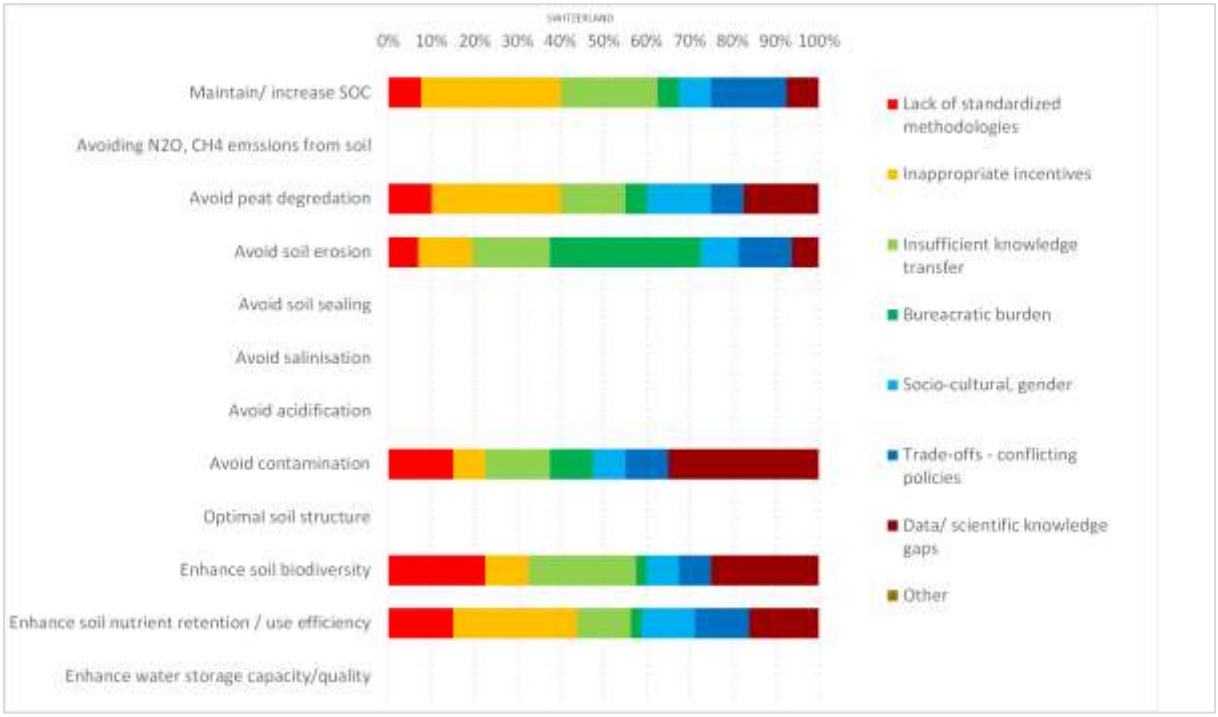

Figure 9 Average weighting, by percentage, of barriers identified by stakeholders in Switzerland to the achievement of multiple soil targets grouped under allocated soil challenges. Allocation soil targets to soil challenges is described in the Appendix (Table 63).

All barriers contributed towards gaps in policy across all the targets identified (Fig. 10). Insufficient knowledge transfer, inappropriate incentives and decreased bureaucratic burden were the most prevalent barriers, followed by lack of standardized methods and data / scientific knowledge gaps. Trade-offs and socio-cultural & gender barriers were less heavily weighted. Hence, the need for more comprehensive policy development that reduces bureaucratic burden and encourages appropriate incentives can be observed in addition to a need for communication that is more effective and sharing of knowledge.

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Table 19 Stakeholder comments corresponding to the soil targets identified by Switzerland.

Stakeholder Identified Target	Stakeholder Comments
Avoidance of permanent compaction in agricultural soils	Conflicts of interest with the buyers of harvest products (e.g. pre-scheduled sugar beet harvest)
No permanent impairment of soil functions through erosion on agricultural land	Conflict no-tillage vs. pesticide reduction
No impairment of water bodies and semi-natural habitats by washed-away soil material from agricultural areas	Farmers do not have to pay for damage to infrastructure, water bodies, etc.
Compensation of soil organic matter losses due to agricultural use of mineral soils.	No economic incentive to increase SOM (or SOM depletion is free)
Minimizing the loss of soil organic matter due to agricultural use of organic soils.	Research gaps regarding economically viable alternatives
No permanent impairment of soil functions, water and natural habitats by pollutants from agriculture.	Very different research needs depending on the topic (pesticides fertilizers, micro plastics).

- Increased knowledge transfer
- Appropriate incentives
- Decreased bureaucratic burden
- Standardized methods

Box 14 Top four priority needs as expressed by Switzerland across all soil challenges

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UK

This country identified five relevant policies and indicated that there were moderate to large gaps between policy targets and realisation of those targets (Table 20).

Table 20 Key policies identified by the UK as having gaps between policy targets and realisation of those targets using a Likert scale where 1 represents a very large gap and 5 represents no gap.

Policies	Gap Rating
Agriculture Bill 2019 - 2021	3
Environmental Bill 2020	3
Sustainable Agricultural Land Management Strategy	2
National Energy and Climate Plan	2
National Well-being Indicators Framework	2

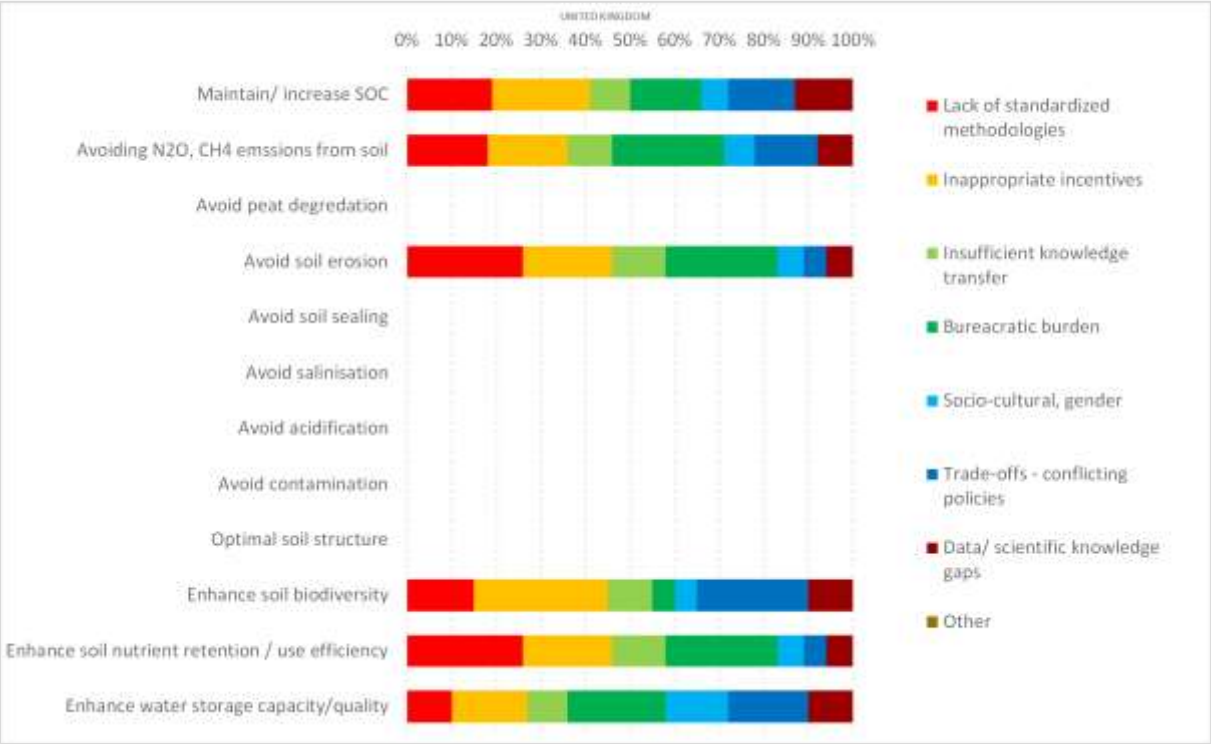

Figure Average weighting, by percentage, of barriers identified by stakeholders in the UK that contribute to gaps in policy with respect to the soil challenges identified. Method of allocation of soil challenges to identified policies can be found in the Appendix (Table 62).

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All barriers contributed to gaps across all soil challenges. Inappropriate incentives and a lack of standardized methods were the most consistently highly weighted barriers followed by bureaucratic burden, trade-offs and data/ scientific knowledge gaps (Fig. 11). Insufficient knowledge transfer and socio-cultural & gender barriers were less weighted across all soil challenges.

- Appropriate incentives
- Decreased bureaucratic burden
- Standardized methods
- Decrease trade-offs with other policies

Box 15 Top four priority needs as expressed by the UK across all soil challenges

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4.1.4 Summary of priority information, research synthesis and knowledge needs expressed by policy stakeholders at all levels

This section has highlighted and identified the knowledge needs and priority information surrounding soil and policies at different scales. Discussions with stakeholders have indicated a significant need for scientific data and tools at both national and regional scales e.g. risk assessment and decision support tools. A need for greater cross collaboration and communication between countries as well as between the relevant soil scientists and policy makers was emphasised. This need for better communication is reinforced by the fact that stakeholders at all forums stated it, especially as it relates to soil biodiversity and ecosystem services. The inclusion of farmers in policy development was strongly emphasized at the EU forum. This was expanded upon at the national forums where farmers' behaviour and on-site practices were discussed. National forums indicated the need to provide farmers with site-specific recommendations and management strategies that are best suited to their region and environmental conditions.

Responses from the different member states via the survey instrument also yielded very useful country specific information on the knowledge needs. Across all twelve responding countries, the gaps in policy target realisation were generally moderate to very large, regardless of country or identified policy. Since the majority of member states matched the policies they identified to the corresponding soil challenges, this parameter was used to allow for greater comparison and standardisation across the data sets. Those countries that only identified policies, subsequently matched them to the relevant soil challenges upon consultation with the authors. Maintaining/ increasing SOC and enhancing soil nutrient retention/ use efficiency were the two most frequently occurring soil challenges (Fig. 12) having been mentioned by eleven out of the twelve respondents. Other frequently mentioned soil challenges are avoiding N2O, CH4 emissions, enhancing soil biodiversity, avoiding soil erosion and enhancing water storage capacity/ quality. This provides insight into the most commonly occurring soil problems within those countries that responded for which there are gaps between policy target and realisation.

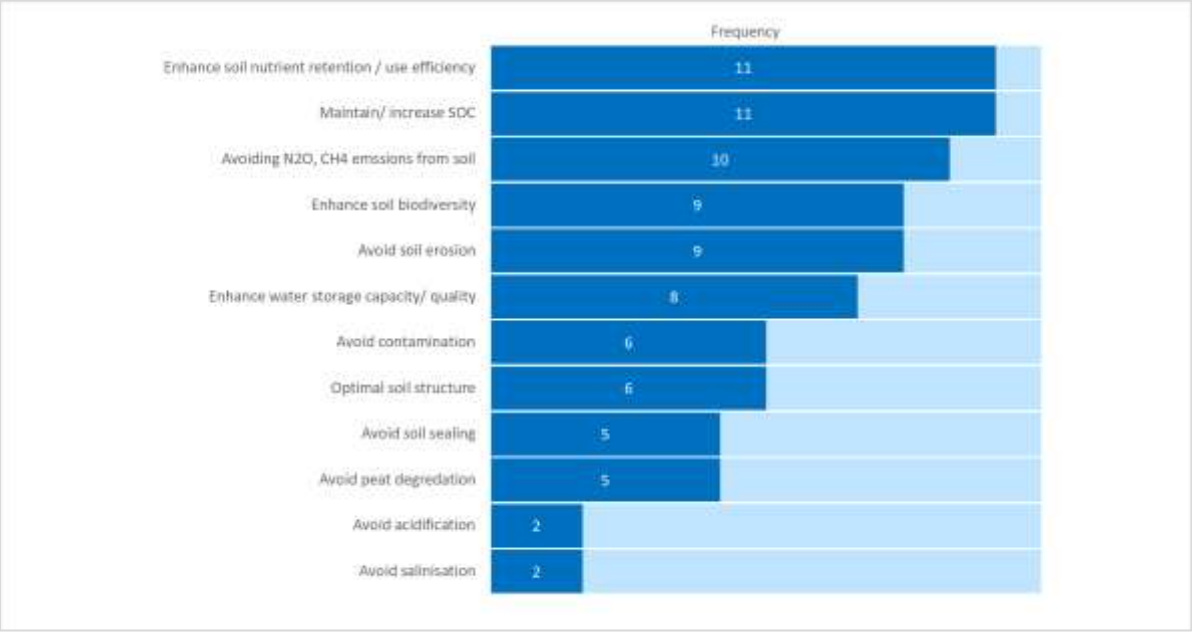

Figure 10 Frequency with which each soil challenge occurred based on responses from all twelve countries.

Further investigation into the barriers that contribute to these gaps revealed that inappropriate incentives was the most commonly occurring barrier, with eleven out of twelve respondents weighting it within their top four barriers. Data & scientific knowledge gaps was the second most common barrier that contributed to these gaps in policy target realisation (Fig. 13). This indicates that across all soil

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challenges and relevant policy there is a great need to revise the currently implemented incentives and ensure that they are appropriately encouraging to allow for implementation of new strategies and practices. There is also a need for more scientific evidence and data to support these policies; however, it is unclear if there is a lack of data or a need for better communication and integration of the existing data into policy.

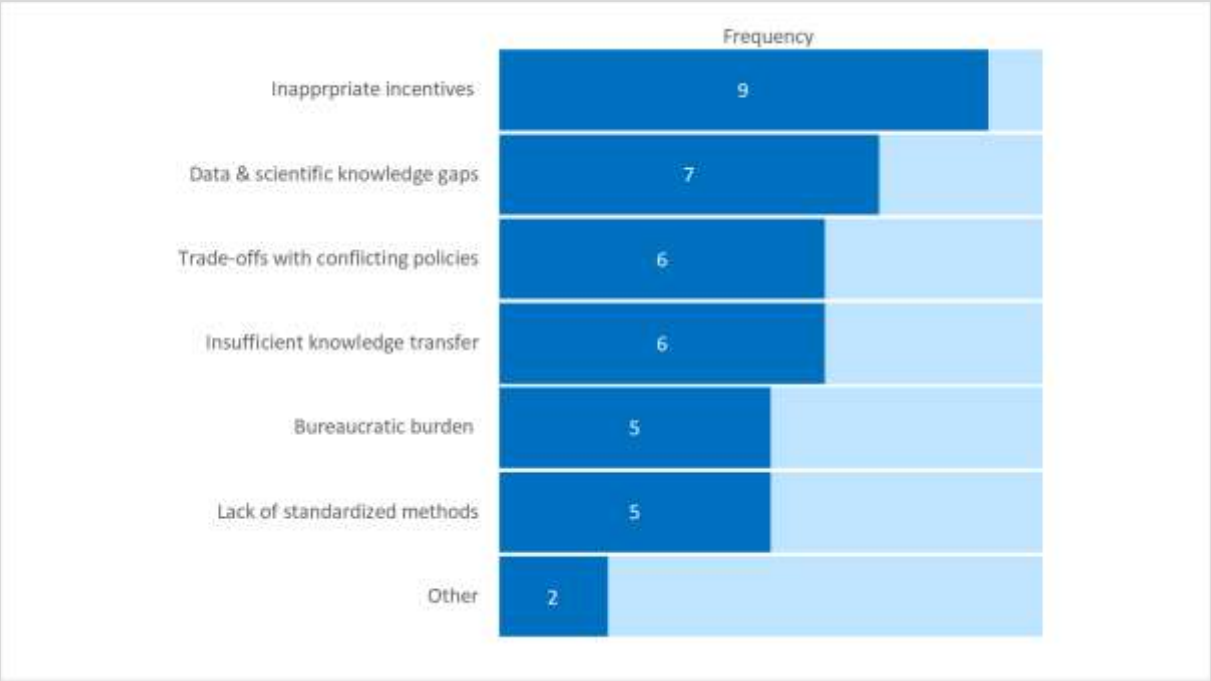

Figure 11 Frequency with which each barrier was ranked in the top four priority barriers by ten of the responding countries. *Data from Italy and Denmark was not available for this exercise.*

A closer look at the ranking of the seven barriers that occurred in the top four spots across the ten respondents considered (data from Italy and Denmark was not available for this exercise), reveals some very interesting trends. Of the nine times that inappropriate incentives was listed in the top four barriers, it was ranked first 55.6% of the time (Fig. 14). While data & scientific knowledge gaps was the second most frequently mentioned barrier, it was ranked in 4th position 42.9% of the times it was mentioned and was never ranked 1st. The Other category was only ranked in the top four by two out of ten countries but those two times it was ranked either 1st or 2nd, indicating the significance of this category and the barriers specified by the respondents to those two member states (France, Netherlands). While insufficient knowledge transfer only had a frequency of six, it was always ranked in either 1st or 2nd position, indicating that while it was not widely mentioned, when it was, it was of high importance.

Overall, many key priority knowledge needs have become known based on the findings described in this section. In an attempt to target those areas identified as contributing the most to current gaps in policy, the focus moving forward should be on harmonization and communication of scientific data as well as the identification of appropriate incentives through further research. A bottom up approach that focuses on collating data at all levels and allowing for site-specific advice via collaboration at all scales is required to address the needs identified.

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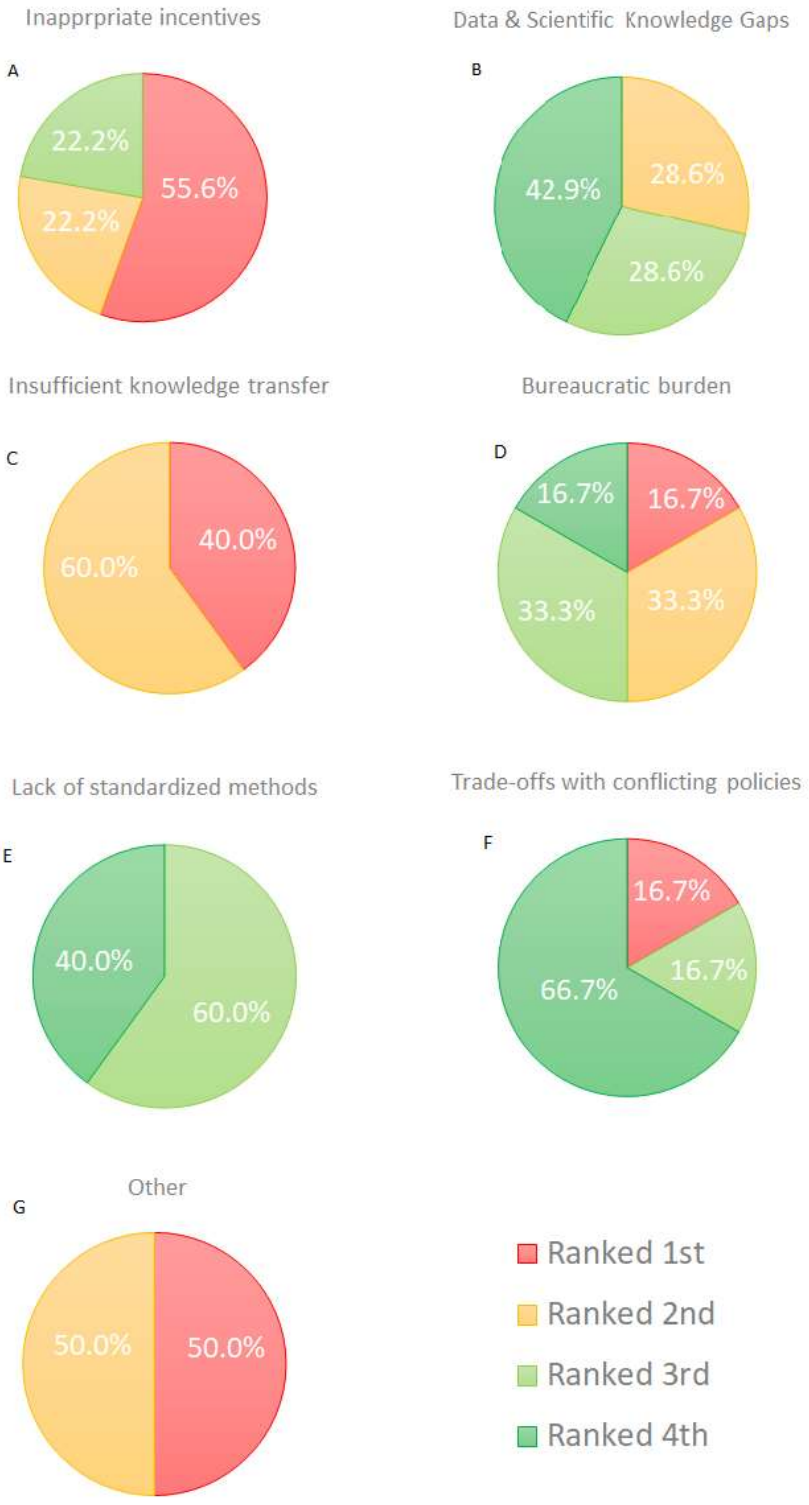

Figure 12 Frequency with which each barrier was ranked in the first, second, third or fourth priority spot.

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4.2 Priority needs for new research

4.2.1 Priority needs for new research expressed at the EU Forum

The EU workshop also allowed for the identification of some of the needs for new research including those in Fig. 15 below.

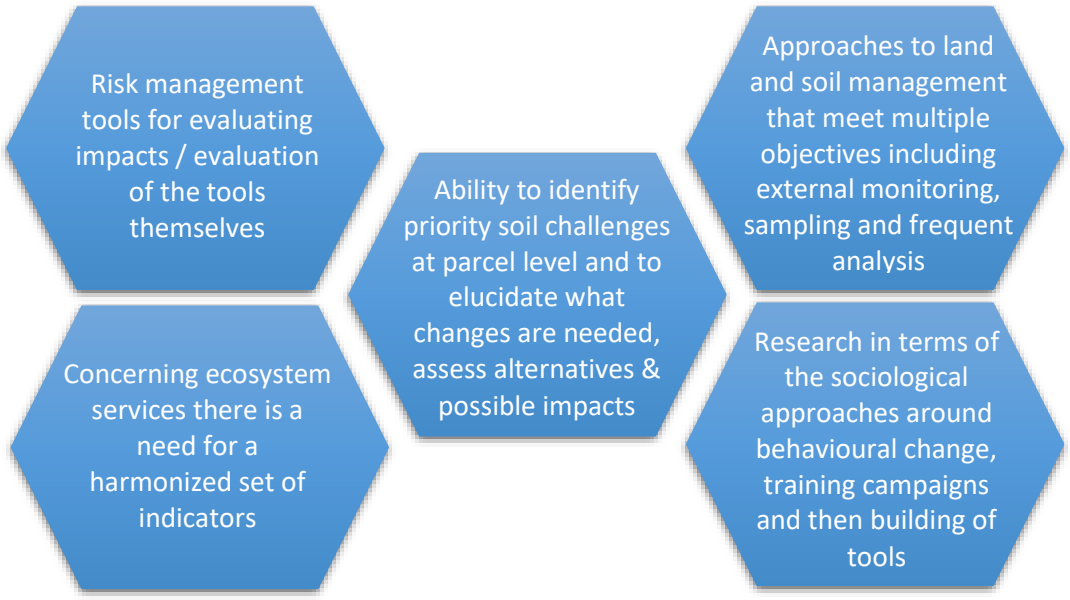

Figure 13 Key needs for new research mentioned by stakeholders during the EU forum

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4.2.2 Priority needs for new research expressed at the National Forums

Several points were raised by stakeholders in all participating countries that identify areas in which new research is needed. There was a difference among the responses given due to the different country priority needs within the same EJP SOIL domains.

Ireland

Table 21 Needs expressed by Irish stakeholders relating to new research areas within key policies related to EJP SOIL.

Policy	Implementation/Adoption	Trade-offs	Monitoring/ Evaluating / Reporting	Scientific Data & Knowledge needs
CAP	Toolkit for farmers & advisors to understand and manage C rich soil	System to assess trade-offs with clear requirements		
	Information from on farm practices	Local responses to local issues		
Climate Action Plan		Reduction in farmer income/animal health		
		Methods that benefit one target may hinder others		
Green Deal	Identify and address sectors/ soil types that are inappropriate		Details of trading system cost/ function	
	Knowledge tools, willingness to adopt change			
Farm to Fork	Knowledge tools: educate farmers/ public with uniform messaging			Soil and sector specific evidence for nutrient requirements
	Increase demand, infrastructure & market support for organic farming			Research into alternatives for pesticides needed and efficacy of products
	Identify and address the sectors/ soil types that are inappropriate			Regional answers for unique issues
Biodiversity Strategy				Scientific evidence for fertilizer reduction effect on soil health
				Scientific data to explain the role of soil biology in mineralisation

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Italy

Table 22 Needs expressed by Italian stakeholders relating to new research areas within the domains of EJP SOIL.

EJP SOIL Domain	Implementation / Adoption	Trade-offs	Monitoring/ Evaluating/ Reporting	Scientific Data & Knowledge Needs
Climate Change Mitigation			Development of indicators and clear relationships between agronomic practices and results on each specific objective	More scientific data needed on the real impacts of CC on Italian agriculture
Climate Change Adaptation	Greater involvement of professional organisations in active dissemination rather than administrative aspects			
Food Security		In EU, food security may mean reducing the need for imports, which is a problem in livestock farming (soybean and maize). This creates imbalances in the nutrient balance at the farm scale, and then an excess of nutrients in soil		
Ecosystem Services			Indicators	Finding ways to assess agricultural ecosystems services that have a direct value for soil protection and making them eligible for incentives under the CAP
Avoiding Land Degradation	Mandatory measures to avoid land sealing	Soil degradation also due to wrong fertilization		

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Latvia

Table 23 Needs expressed by Latvian stakeholders relating to new research areas within targets of emerging policies.

Policy & Target	Implementation / Adoption	Monitoring/ Evaluating/ Reporting	Scientific Data & Knowledge Needs
F2F – Reduction in use of chemical & hazardous pesticides by 2030	Research into the use of economically beneficial organic plant protection methods in large sized farms		New research into the persistence of pesticide residues in Latvian soils
			Investigate suitable alternatives to pesticide use with minimal adverse economic and ecological effects
GD- Reduction of greenhouse gases to zero net emissions by 2050		Further development and research of the methods used to measure CO2 emissions in the boreal zone	

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4.3.3 Priority needs for new research expressed in Survey Responses

For this section of the survey instrument, C) Horizon Scanning, respondents were asked to answer to a series of questions about specifically identified targets within four emerging policies: European Green Deal, CAP, Farm to Fork and the Biodiversity Strategy. Answers to the questions were in the format: agree/yes, partly agree and disagree/no. These qualitative responses were then assigned a numerical value and value ranges were assigned a corresponding icon (negative, neutral, positive), a detailed explanation of this process can be found in the Appendix (Table 65).

In cases where individual stakeholder responses were received (Austria, Germany, Latvia) the average of the assigned numerical values across the number of respondents was taken as the summary value used in the final table. The detailed method for this can be found in the Appendix (Table 66).

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Austria

Table 24 Responses by Austria to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X). Blank spaces correspond to either no response or an 'unknown' response.

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?	Please specify indicator and unit if known	Is this indicator harmonised across EU?	Is indicator robust, reliable and statistically validated?	Monitoring Requirements -is a clearly defined monitoring review time period established?	Are reference (baseline) values and / or interpretation of indicators established?	Reporting Requirements - Are data available when needed and readily revised if required?
GREEN DEAL									
Emissions Trading System	✓	✓	✓	t CO2	✓	–	✓	✓	✓
Member State targets to reduce emissions in sectors outside the Emissions Trading System	✓	✓	✓	GHG inventory; NEC guidelines; projections; t CO2	✓	✓	✓	✓	✓
Regulation on land use, land use change and forestry to include removals from land, land use change and forestry.	–	✓	✓	Soil C content (measurable but is not measured each year); projections; LULUCF - land use categories; sealed ares per capita; sealed area per settlement area	✓	✓	✓	✓	✓
Limit/exclude Carbon Leakage where incoherence at global scale is found	–	✓	✗					✗	
Climate change Adaptation ustilising nature-based solutions	✓	–	–		✓	✓	–	–	–
CAP									
Enhanced Conditionality	–	✓	✓	amount of farms in the program, size of area covered	✓	✓	✓	✓	✓
Eco-schemes	✓	✓	✓	amount of farms in the program, size of area covered	✓	✓	✓	✓	✓
Farm Advisory Service	✓	✓	✓	amount of consultations (but does not cover qualitative aspect)	–	✓	✓	✓	✓
Agri-environment-climate measures and investments	✓	✓	✓	amount of accessed funds	–	✓	✓	✓	✓

Table 25 Responses by Austria to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X). Blank spaces correspond to either no response or an 'unknown' response.

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?	Please specify indicator and unit if known	Is this indicator harmonised across EU?	Is indicator robust, reliable and statistically validated?	Monitoring Requirements -is a clearly defined monitoring review time period established?	Are reference (baseline) values and / or interpretation of indicators established?	Reporting Requirements - Are data available when needed and readily revised if required?
FARM TO FORK									
Reduction by 50% of the use and risk of pesticides	✓	–	✓	sales numbers	–	–	✓	✓	✓
Reduction by at least 20% of the use of fertilizers	✓	–	✓	sales numbers	–	–	✓	✓	✓
A reduction by 50% in sales of antimicrobials used for farmed animals and aquaculture	✓	–	✓	sales numbers	–	–	✓	✓	✓
Reaching 25% of agricultural land under organic farming	✓	–	✓	number of organic farms; area of organic farms	✓	✓	✓	✓	✓
BIODIVERSITY STRATEGY									
Binding targets to restore damaged ecosystems and rivers.	✓	✓	✓	river quality index	✗	✓	✓	✓	✓
Improve the health of EU protected habitats and species	✓	✓	–		–	✗	✓	–	–
Bring back pollinators to agricultural land	✓	✓	✗		✗	✗	✓	✗	✗
Reduce pollution	✓	✓			✗	✗	✓	✗	✗
Green our cities	✓	✓	✗		✗	✗	✓	✗	✗
Enhance organic farming and other bio-diversity friendly farming practices	✓	–	✓	area of land under organic management	–	–	✓	–	✓
Improve the health of European forests.	✓	✓	✗		✗	✗	✓	✗	✗
Transform 30% of Europe's lands and seas into protected areas	✓	–	✓	area of protected areas	–	✓	✓	✓	✓
Bring back at least 10% of agricultural area under high-diversity landscape features.	✓	✓	✓	landscape diversity index	✗	✓	–	✓	✓

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Based on the responses from this member state there is a sufficiently clear definition of policy intent as well as sufficient scientific evidence to support policy targets within the identified emerging policies. A number of measurable indicators exist and are specified in detail for achieving the targets outlined. Some research still does need to be done to determine measurable indicators for the following targets:

- Limit/ exclude carbon leakage where incoherence at a global scale is found (GD)
- Bring back pollinators to agricultural land (BS)
- Green our cities (BS)
- Improve the health of European forests (BS)

Table 26 Austrian stakeholder comments on the various targets under the policies outlined in the survey instrument.

Policy	Target	Stakeholder Comments
Green Deal	The regulation on land use, land use change and forestry to include removals from land, land use change and forestry.	Projections; assessment of climatic changes are questionable
CAP	Farm Advisory Service	Quantitative evaluation of advisory service; no indicators for qualitative aspects
Farm to Fork	Reduction by 50% of the use and risk of pesticides	EC has not shared their evidence base, has not performed an impact assessment; it is a political decision; sales numbers can be used as indicator
	Reduction by at least 20% of the use of fertilizers	Sales numbers can be used as indicators but are assessed differently in each country
	Reaching 25% of agricultural land under organic farming	Number of farms, area (ha) as indicators

Belgium

Table 27 Responses by Belgium to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X).Blank spaces correspond to either no response or an 'unknown' response.

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?	Please specify indicator and unit if known	Is this indicator harmonised across EU?	Is indicator robust, reliable and statistically validated?	Monitoring Requirements -is a clearly defined monitoring review time period established?	Are reference (baseline) values and / or interpretation of indicators established?	Reporting Requirements - Are data available when needed and readily revised if required?
GREEN DEAL									
Emissions Trading System	▬	▬	✓	✓	✓	✓	✓	✓	✓
Member State targets to reduce emissions in sectors outside the Emissions Trading System	▬	▬	✓	✓	✓	✓	✓	✓	✓
Regulation on land use, land use change and forestry to include removals from land, land use change and forestry.	✓	▬	✓	✓		✗	✓		
Limit/exclude Carbon Leakage where incoherence at global scale is found	▬	▬		✗	✓	✓			
Climate change Adaptation ustilising nature-based solutions	▬	▬	✗	✗	✗	✗	✗	✗	✗
CAP									
Enhanced Conditionality	✓		✓	✓	✗			✗	✓
Eco-schemes	✓	▬	✓	✓	✗	✗	✓	✓	✓
Farm Advisory Service	✓		✓	✓	✗			✗	✓
Agri-environment-climate measures and investments	✓		✓	✓	✓	✓	✓	✓	✓

Table 28 Responses by Belgium to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X).Blank spaces correspond to either no response or an 'unknown' response.

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?	Please specify indicator and unit if known	Is this indicator harmonised across EU?	Is indicator robust, reliable and statistically validated?	Monitoring Requirements -is a clearly defined monitoring review time period established?	Are reference (baseline) values and / or interpretation of indicators established?	Reporting Requirements - Are data available when needed and readily revised if required?
FARM TO FORK									
Reduction by 50% of the use and risk of pesticides	✓		✓	✓	✗			✗	✓
Reduction by at least 20% of the use of fertilizers	✓	–	✓	✓	✗	✗	✓	✓	✓
A reduction by 50% in sales of antimicrobials used for farmed animals and aquaculture	✓		✓	✓	✗			✗	✓
Reaching 25% of agricultural land under organic farming	✓		✓	✓	✓	✓	✓	✓	✓
BIODIVERSITY STRATEGY									
Binding targets to restore damaged ecosystems and rivers.	–	–	✗		✗			✗	✓
Improve the health of EU protected habitats and species	–	–			✗	✓		✗	✓
Bring back pollinators to agricultural land	–	–	✓	✓	✗	✓	✓		✓
Reduce pollution	–	–	✓	✓		✓	✓		✓
Green our cities	–	–	✗		✗			✗	
Enhance organic farming and other bio-diversity friendly farming practices	–	–	✓	✓	✓	✓	✓		✓
Improve the health of European forests.	–	–						✗	✓
Transform 30% of Europe's lands and seas into protected areas	✓		✓	✓		✓	✓	✗	✓
Bring back at least 10% of agricultural area under high-diversity landscape features.	–		✓	✓	✗	✓	✓	✗	✓

Strategy policies. Responses also indicate a need for new research to harmonise the indicators used as well as to develop measureable indicators for the following specific targets:

- Restoring ecosystems and rivers (BS)
- Greening cities (BS)
- Climate change adaptation using nature based solutions (GD)

Table 29 Belgian stakeholder comments on the various targets under the policies outlined in the survey instrument.

Policy	Target	Stakeholder Comments
Green Deal		Strict regulations on monitoring will have to be adapted for achieving the targets here which deal with changes and shifts in the system.
CAP		Policy indicators are very bureaucratic, need for indicators to focus on results such as increased C content, reduced erosion rates, increased biodiversity.
	Erosion	An established indicator for erosion exists (Cantreul et al. 2020)
	SOC	Need for a sufficient amount of analyses for farmers
	Eco-Schemes	Possible indicator under consideration, effective organic carbon (EOC). EOC values need scientific revision, possible through EJP SOIL Carbo Seq.
Farm to Fork	Nutrient use reduction indicators	Manure balance and nitrate residue. Manure balance is calculated each year (per farm). Nitrate residue can be viewed per cultivation per soil texture (weighted) averages at farm level, over Flanders.
Biodiversity Strategy		There is a need for certification rules and a certified MRV system for carbon accounting at the farm level that is accurate yet cost-effective. Ideally, the rules for certification would be agreed on by policy. Long-term policy-science collaboration is needed to establish a scientifically sound MRV system that could be based on basic payments for measures taken (and a model prediction) and top-up payments based on results (could be verification at regional level of the used models at multiple long-term monitored plots at pilot farms).

Denmark

Table 30 Responses by Denmark to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X).Blank spaces correspond to either no response of an 'unknown' response.

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?	Please specify indicator and unit if known	Is this indicator harmonised across EU?	Is indicator robust, reliable and statistically validated?	Monitoring Requirements -Is a clearly defined monitoring review time period established?	Are reference (baseline) values and / or interpretation of indicators established?	Reporting Requirements - Are data available when needed and readily revised if required?
GREEN DEAL									
Emissions Trading System	=	✗					=	=	=
Member State targets to reduce emissions in sectors outside the Emissions Trading System	=	✗	✓	GHG emissions - CO2E			✗	✗	✗
Regulation on land use, land use change and forestry to include removals from land, land use change and forestry.	=	=	You mention 4-5 differnet aspects, for some there are indicators, for orther not				=	=	=
Limit/exclude Carbon Leakage where incoherence at global scale is found	=	✗	✗						
Climate change Adaptation ustilising nature-based solutions	=	=	=		=	=	✗	✓	✓
FARM TO FORK									
Reduction by 50% of the use and risk of pesticides	✓	✓	✓	Treatment index - pesticides	✗	✓	✓	✓	✓
Reduction by at least 20% of the use of fertilizers	✓	✓	✓	Nutrient use	✓	✓	✓	✓	✓
A reduction by 50% in sales of antimicrobials used for farmed animals and aquaculture	✓	✓	✓	Treatment index - antimicrobials	=	✓	✓	✓	✓
Reaching 25% of agricultural land under organic farming	✓	✓	✓	% of area under oganic farming	✓	✓	✓	✓	✓

Responses indicated that there is a greater need for clearly defined policy intent and scientific evidence to support policy around the Green Deal. These targets were also indicated to generally lack measureable indicators that were harmonised or robust. In contrast, responses to targets within the Farm to Fork policy indicated sufficiently clearly defined policy intent and supporting evidence as well as existing measureable indicators for all targets.

Data was only submitted for the two emerging policies shown. With respect to the two polices not included this member state had these comments.

Common Agricultural Policy - "The Danish CAP plan is currently under development and the content of these instruments have not yet been decided, so this cannot be answered at present for the forthcoming CAP plan (and they are not part of the current, so we cannot even answer based on this). Negotiations are pending and are expected to be final in late May"

Biodiversity Strategy –"Our data acquisition has focused on soil and soil related policies and issues, the aspects mentioned under the biodiversity strategy are rather general, we have no basis for making this assessment."

France

Table 31 Responses by France to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X). Blank spaces correspond to either no response of an 'unknown' response.

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?	Please specify indicator and unit if known	Is this indicator harmonised across EU?	Is indicator robust, reliable and statistically validated?	Monitoring Requirements -is a clearly defined monitoring review time period established?	Are reference (baseline) values and / or interpretation of indicators established?	Reporting Requirements - Are data available when needed and readily revised if required?
GREEN DEAL									
Emissions Trading System	✗	✗	✗		✗		✗	✓	✗
Member State targets to reduce emissions in sectors outside the Emissions Trading System	✗	✗	✗		✗		✗	✓	✗
Regulation on land use, land use change and forestry to include removals from land, land use change and forestry.	✗	✗	✗		✗		✗	✗	✗
Limit/exclude Carbon Leakage where incoherence at global scale is found	✗	✗	✗		✗		✗	✗	✗
Climate change Adaptation ustilising nature-based solutions	✗	✗	✗		✗		✗	✗	✗
CAP									
Enhanced Conditionality	✓	✓	✗		✗		✗	✗	✗
Eco-schemes	✓		✗		✗		✗	✗	✗
Farm Advisory Service	✗	✓	✗		✗		✗	✗	✗
Agri-environment-climate measures and investments		▬	✗		✗		✗	✗	✗

Table 32 Responses by France to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X). Blank spaces correspond to either no response of an 'unknown' response.

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?	Please specify indicator and unit if known	Is this indicator harmonised across EU?	Is indicator robust, reliable and statistically validated?	Monitoring Requirements - is a clearly defined monitoring review time period established?	Are reference (baseline) values and / or interpretation of indicators established?	Reporting Requirements - Are data available when needed and readily revised if required?
FARM TO FORK									
Reduction by 50% of the use and risk of pesticides	✗		–		✗		✗	✗	✗
Reduction by at least 20% of the use of fertilizers	✗		–		✗		✗	✗	✗
A reduction by 50% in sales of antimicrobials used for farmed animals and aquaculture	✗		✗		✗		✗	✗	✗
Reaching 25% of agricultural land under organic farming	✗		✗		✗		✗	✗	✗
BIODIVERSITY STRATEGY									
Binding targets to restore damaged ecosystems and rivers.	✓	–	✓		✓		–	–	–
Improve the health of EU protected habitats and species	–	–	✓		✗		–	–	–
Bring back pollinators to agricultural land	✗	–	✗		✗		✗	✗	✗
Reduce pollution	–	–	–		✗		✗	✗	✗
Green our cities	✗	–	✗		✗		✗	✗	✗
Enhance organic farming and other bio-diversity friendly farming practices	✗	–	✗		✗		✗	✗	✗
Improve the health of European forests.	✗	–	✗		✗		✗	✗	✗
Transform 30% of Europe's lands and seas into protected areas	✗	–	✗		✗		✗	✗	✗
Bring back at least 10% of agricultural area under high-diversity landscape features.	✗	–	✗		✗		✗	✗	✗

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A substantial need for clearer policy intent, greater scientific evidence to support policy as well as the need for the development of measureable indicators for all policies. Specifically highlighted within Table 9 above are the European Green Deal (GD) and the Farm to Fork (F2F) strategy as lacking clear policy intent and definition while the Biodiversity Strategy and CAP are only slightly more well defined.

Germany

Table 33 Responses by Germany to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X).Blank spaces correspond to either no response of an 'unknown' response

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?	Is this indicator harmonised across EU?	Is indicator robust, reliable and statistically validated?	Monitoring Requirements -is a clearly defined monitoring review time period established?	Are reference (baseline) values and / or interpretation of indicators established?	Reporting Requirements - Are data available when needed and readily revised if required?
GREEN DEAL								
Emissions Trading System	–	–	✓	✓	✓	–	✓	✗
Member State targets to reduce emissions in sectors outside the Emissions Trading System	✓	✓	✓	✓	✓	✓	✓	✓
Regulation on land use, land use change and forestry to include removals from land, land use change and forestry.	✓	–	✓	✓	✓	✓	✓	–
Limit/exclude Carbon Leakage where incoherence at global scale is found	✓	✓	✗	✗	✗	✗		✗
Climate change Adaptation ustilising nature-based solutions	✓	✓	✗	✗		–	✗	✗
CAP								
Enhanced Conditionality	✓	✓	✓	✓	✓	✓	✓	✓
Eco-schemes	✓	✓				✓		
Farm Advisory Service	✓	✓	✗					
Agri-environment-climate measures and investments	✓	✓	✓	–	✓	✓		✓

Table 34 Responses by Germany to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X).Blank spaces correspond to either no response of an 'unknown' response

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?	Is this indicator harmonised across EU?	Is indicator robust, reliable and statistically validated?	Monitoring Requirements -is a clearly defined monitoring review time period established?	Are reference (baseline) values and / or interpretation of indicators established?	Reporting Requirements - Are data available when needed and readily revised if required?
FARM TO FORK								
Reduction by 50% of the use and risk of pesticides	✓	✓	✓	✓	✓	✗	✗	✓
Reduction by at least 20% of the use of fertilizers	✓	✓	✓	✓		✗	✗	
A reduction by 50% in sales of antimicrobials used for farmed animals and aquaculture	✓	✓	✓	✓	✓	✗	✗	
Reaching 25% of agricultural land under organic farming	✓	✓	✓	✓	✓	✓	✓	✓
BIODIVERSITY STRATEGY								
Binding targets to restore damaged ecosystems and rivers.	✓	✓	–	✗		✗	✗	✓
Improve the health of EU protected habitats and species	✓	✓	–	✓	✓	✓	✓	✓
Bring back pollinators to agricultural land	✓	✓	–	✓	✓	✓		
Reduce pollution	✓	✓	✗	✗				
Green our cities	✓	✓	–	✓	✓	✗		✓
Enhance organic farming and other bio-diversity friendly farming practices	✓	✓	–	✗	✗	✗	✗	✗
Improve the health of European forests.	✓	✓	–			✓		
Transform 30% of Europe's lands and seas into protected areas	✓	✓	✓	✓	✓			
Bring back at least 10% of agricultural area under high-diversity landscape features.	✓	✓	✗					

With respect to this member state, there is a sufficient definition of policy intent as well as scientific evidence to support all the emerging policies. The majority of targets were viewed to possess measureable indicators even if they were not specified by the respondents. The targets that require new research to develop measureable indicators are:

- Limiting/excluding C leakage where incoherence at global scale is found (GD)
- CC Adaptation using nature based solutions (GD)
- Farm advisory service (CAP)
- Reducing pollution (BS)
- Bring back 10% agricultural area under high diversity landscape features (BS)

Table 35 German stakeholder comments on the various targets under the policies outlined in the survey instrument.

Policy	Target	Stakeholder Comments
Green Deal		The introduction of LULUCF into the ETS is under discussion but further work is needed for inclusion. The indicator would be CO_2 eq. No systematic monitoring regarding soil carbon/ soil quality effects.
CAP	Erosion	There are suitable indicators for water and wind erosion across the EU but they are not uniformly implemented.
	Eco-schemes	Soil is likely to benefit indirectly from the attention paid to biodiversity.
	Farm advisory service	Indicators to assess advice that targets soil management/ improvement are needed.
Farm to Fork		Significant further clarification of policy intent is required, especially how certain targets directly relate to soil. Fertilizer sales, not use, are recorded and only for commercially available fertilizers.
Biodiversity Strategy		Species living in soil/ underground not addressed but may benefit indirectly. Very broad targets that can possibly encompass a number of soil parameters need for clarification is present. Clearer harmonized definitions of terms used e.g. “biodiversity friendly practices”.

Ireland

Table 36 Responses by Ireland to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X).Blank spaces correspond to either no response of an 'unknown' response.

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?	Please specify indicator and unit if known	Is this indicator harmonised across EU?	Is indicator robust, reliable and statistically validated?	Monitoring Requirements -is a clearly defined monitoring review time period established?	Are reference (baseline) values and / or interpretation of indicators established?	Reporting Requirements - Are data available when needed and readily revised if required?
GREEN DEAL									
Emissions Trading System	✓	–	✓	credits or pricing based on CO2 eq (Agriculture	✗		✗	✗	✗
Member State targets to reduce emissions in sectors outside the Emissions Trading System	–	–	✗		✗				
Regulation on land use, land use change and forestry to include removals from land, land use change and forestry.	✓	✓			✗		✗		
Limit/exclude Carbon Leakage where incoherence at global scale is found	–	–	✗		✗		✗		
Climate change Adaptation ustilising nature-based solutions	–	✗	✗		✗		✗	✗	✗
CAP									
Enhanced Conditionality	–				✗		✗		
Eco-schemes	–	–	–	Depends on the objective/target	✗		✗		
Farm Advisory Service	–	✓	✗		✗		✗	✓	✓
Agri-environment-climate measures and investments	✗	–	✓	Depends on the measure/target: e.g cost /linear m/ cost per ha etc	✗		✗	✓	✓

Table 37 Responses by Ireland to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X).Blank spaces correspond to either no response of an 'unknown' response.

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?	Please specify indicator and unit if known	Is this indicator harmonised across EU?	Is indicator robust, reliable and statistically validated?	Monitoring Requirements - is a clearly defined monitoring review time period established?	Are reference (baseline) values and / or interpretation of indicators established?	Reporting Requirements - Are data available when needed and readily revised if required?
FARM TO FORK									
Reduction by 50% of the use and risk of pesticides	–	✗	–		✗		✗		
Reduction by at least 20% of the use of fertilizers	✓	–	✓	National scale: Annual tonnes N fertiliser. Farm scale: Annual Nitrogen rate (kg/ha) / N balance/ha	✓	–	✗	✓	✓
A reduction by 50% in sales of antimicrobials used for farmed animals and aquaculture	✓	–	–		✗		✗		
Reaching 25% of agricultural land under organic farming	✓	✓	–		✗		✗		
BIODIVERSITY STRATEGY									
Binding targets to restore damaged ecosystems and rivers.	–	–			✗		✗	✗	✗
Improve the health of EU protected habitats and species	–	✓			✗		✗		✗
Bring back pollinators to agricultural land	–		✓		✗		✗		✗
Reduce pollution	–	✓			✗		✗		✗
Green our cities	–				✗		✗		✗
Enhance organic farming and other bio-diversity friendly farming practices	–	–			✗		✗		✗
Improve the health of European forests.	✓				✗		✗		✗
Transform 30% of Europe's lands and seas into protected areas		–			✗		✗		✗
Bring back at least 10% of agricultural area under high-diversity landscape features.	✓	–			✗		✗		✗

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There is a need for greater definition of policy intent as well as a need for more scientific evidence to support the policy targets listed across all policies. This member state identified very few measureable indicators for the targets within the policies and there is a great need for new research to develop measureable indicators for the following:

- Member state targets to reduce emission in sectors outside the ETS (GD)
- Limit/ exclude carbon leakage where incoherence at global scale is found (GD)
- Climate change adaptation using nature-based solutions (GD)
- Farm advisory service (CAP)
- Reduction by 50% of the use and risk of pesticides (F2F)

Latvia

Table 38 Responses by Latvia to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X).Blank spaces correspond to either no response of an 'unknown' response.

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?	Please specify indicator and unit if known	Is this indicator harmonised across EU?	Is indicator robust, reliable and statistically validated?	Monitoring Requirements - is a clearly defined monitoring review time period established?	Are reference (baseline) values and / or interpretation of indicators established?	Reporting Requirements - Are data available when needed and readily revised if required?
GREEN DEAL									
Emissions Trading System	✓	✓	–	–	–	–	✓	✓	✓
Member State targets to reduce emissions in sectors outside the Emissions Trading System	✓	✓	–	–	–	–	✓		✓
Regulation on land use, land use change and forestry to include removals from land, land use change and forestry.	✓	–	–	–	–	–	–		✓
Limit/exclude Carbon Leakage where incoherence at global scale is found	✓	✓	–	–	–	–	✓		
Climate change Adaptation ustilising nature-based solutions	–	✓	✓	✓	–	–	✓	✗	✗
CAP									
Enhanced Conditionality	✓	✓	✓	–		–	✓	✓	✓
Eco-schemes	✓	✓	✓	–			✓	✓	✓
Farm Advisory Service	✓	✓	–	–		–	✓	✓	
Agri-environment-climate measures and investments	–	✓	✓	–		✓	✓	✓	✓

Table 39 Responses by Latvia to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X).Blank spaces correspond to either no response of an 'unknown' response.

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?	Please specify indicator and unit if known	Is this indicator harmonised across EU?	Is indicator robust, reliable and statistically validated?	Monitoring Requirements - is a clearly defined monitoring review time period established?	Are reference (baseline) values and / or interpretation of indicators established?	Reporting Requirements - Are data available when needed and readily revised if required?
FARM TO FORK									
Reduction by 50% of the use and risk of pesticides	✓	✓	✓	✓	✓	–	✓	✓	✓
Reduction by at least 20% of the use of fertilizers	✓	✓	✓	✓	–	–	✓	✓	✓
A reduction by 50% in sales of antimicrobials used for farmed animals and aquaculture	✓	✓	✓	✓	–	–	✓	✓	✓
Reaching 25% of agricultural land under organic farming	✓	✓	✓	✓	✓	–	✓	✓	✓
BIODIVERSITY STRATEGY									
Binding targets to restore damaged ecosystems and rivers.	✓	–	–	–	✓	–	✓	✓	✓
Improve the health of EU protected habitats and species	✓	–	–	–	✓	✓	✓		✓
Bring back pollinators to agricultural land	✓	✓	–	–	✓	✓	✓		✗
Reduce pollution	✓	✓	✗	✓	✓	✓	✓	✓	✓
Green our cities	✓	✓	–	✓	✓	✓	✓		✗
Enhance organic farming and other bio-diversity friendly farming practices	✓	✓	✓	✓	✓	✓	✓	✓	✓
Improve the health of European forests.	✓	–	✓	✓	✓	–	✓		✓
Transform 30% of Europe's lands and seas into protected areas	✓	✓	–	–	–	–	✓	✓	✓
Bring back at least 10% of agricultural area under high-diversity landscape features.	✓	✓	–		–	–	✓	✓	

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Policy intent is clearly defined and there is sufficient scientific evidence to support the listed policies and the targets within them based on the responses of stakeholders from this member state. Responses indicate that there are measureable indicators available for a majority of targets, however do not provide information on these indicators in their responses in the table. The only target identified as not having a clear measureable indicator was “Reducing pollution” under the Biodiversity Strategy.

Table 40 Latvian stakeholder comments on the various policies outlined in the survey instrument.

Policy	Stakeholder Comments
Green Deal	Administrative costs of free allocation, stable registry system, Cost Per-Unit-Performance, households’ costs for DH etc.; Cost of carbon emissions
Farm to Fork	Organic farming indicator: certified area under organic farming (ha)
Biodiversity Strategy	Need for clarification of the indicator systems, baseline year etc. within the policy.

Netherlands

Table 41 Responses by the Netherlands to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X).Blank spaces correspond to either no response of an 'unknown' response.

	Policy intent is clearly defined	Scientific evidence base to support policy exists
GREEN DEAL		
Emissions Trading System		
Member State targets to reduce emissions in sectors outside the Emissions Trading System	▬	
Regulation on land use, land use change and forestry to include removals from land, land use change and forestry.	✓	
Limit/exclude Carbon Leakage where incoherence at global scale is found		
Climate change Adaptation ustilising nature-based solutions		
CAP		
Enhanced Conditionality	▬	✓
Eco-schemes	▬	✓
Farm Advisory Service	▬	✓
Agri-environment-climate measures and investments	▬	✓
FARM TO FORK		
Reduction by 50% of the use and risk of pesticides	▬	▬
Reduction by at least 20% of the use of fertilizers	▬	▬
A reduction by 50% in sales of antimicrobials used for farmed animals and aquaculture	▬	▬
Reaching 25% of agricultural land under organic farming	✗	▬

Responses by this member state indicate that policy intent is only partially defined and greater clarification is required. Similarly, there is some scientific evidence to support the listed policy targets. However, there remains room for greater development of scientific evidence for policy support especially for the European Green Deal and Farm to Fork targets.

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Poland

Table 42 Responses by Poland to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X).Blank spaces correspond to either no response of an 'unknown' respon

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?	Please specify indicator and unit if known	Is this indicator harmonised across EU?	Is indicator robust, reliable and statistically validated?	Monitoring Requirements -is a clearly defined monitoring review time period established?	Are reference (baseline) values and / or interpretation of indicators established?	Reporting Requirements - Are data available when needed and readily revised if required?
GREEN DEAL									
Emissions Trading System	✓	✓	✓	✓	✓	✓	✓	✓	✓
Member State targets to reduce emissions in sectors outside the Emissions Trading System	✓	✓	✓	✓	✓	✓	✓	✓	✓
Regulation on land use, land use change and forestry to include removals from land, land use change and forestry.	–	–	✓	✓	✓	✓	✓	✓	✗
Limit/exclude Carbon Leakage where incoherence at global scale is found	–	–	✓	✓	✓	✓	✓		
Climate change Adaptation ustilising nature-based solutions	–	–	✓	✓	✓	✓	✓	✓	✗
CAP									
Enhanced Conditionality	–	–	✓	✓	✓	✓	✓	✓	✗
Eco-schemes	–	–	✓	✓	✓		✓	✓	✗
Farm Advisory Service	–	–	✓	✓	✓	✓	✓	✓	✗
Agri-environment-climate measures and investments	–	–	✓	✓	✓	✗	✓	✓	✗

Table 43 Responses by Poland to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X).Blank spaces correspond to either no response of an 'unknown' response.

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?	Please specify indicator and unit if known	Is this indicator harmonised across EU?	Is indicator robust, reliable and statistically validated?	Monitoring Requirements -is a clearly defined monitoring review time period established?	Are reference (baseline) values and / or interpretation of indicators established?	Reporting Requirements - Are data available when needed and readily revised if required?
FARM TO FORK									
Reduction by 50% of the use and risk of pesticides	✓	✓	✓	✓	✓	✗	✓	✗	✗
Reduction by at least 20% of the use of fertilizers	✓	✓	✓	✓	✓	✓	✓	✓	✓
A reduction by 50% in sales of antimicrobials used for farmed animals and aquaculture	–	–	✓	✓	✓	✗	✓	✗	✗
Reaching 25% of agricultural land under organic farming	–	–	✓	✓	✓	✓	✓	✓	✓
BIODIVERSITY STRATEGY									
Binding targets to restore damaged ecosystems and rivers.	✓	✓	✓	✓	✓	✗	✓		
Improve the health of EU protected habitats and species	✓	✓	✓	✓	✓	✗	✓	✓	✗
Bring back pollinators to agricultural land	✓	✓	✓	✓	✓		✓	✓	✗
Reduce pollution	✓	✓	✓			✗	✓	✓	✓
Green our cities	–	–							
Enhance organic farming and other bio-diversity friendly farming practices	–	–						✗	✗
Improve the health of European forests.	–	–	✓	✓	✓	✓	✓		✗
Transform 30% of Europe's lands and seas into protected areas	–	–	✓	✓	✓	✓	✓	✓	✓
Bring back at least 10% of agricultural area under high-diversity landscape features.	–	–	✓	✓	✓	✓	✓	✗	✗

Based on the responses above this member state indicates that policy targets are generally partially well defined and there is sufficient evidence to support policies with room for increased scientific supporting evidence especially in the Common Agricultural Policy. The majority of targets were indicated to possess measureable indicators that were viewed by this member state to be generally harmonised across the EU.

Switzerland

Table 44 Responses by Switzerland to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X).Blank spaces correspond to either no response of an 'unknown' response.

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?	Please specify indicator and unit if known	Is this indicator harmonised across EU?	Is indicator robust, reliable and statistically validated?	Monitoring Requirements -is a clearly defined monitoring review time period established?	Are reference (baseline) values and / or interpretation of indicators established?	Reporting Requirements - Are data available when needed and readily revised if required?
Swiss Soil Strategy									
Avoidance of permanent compaction in agricultural soils	✓	✓	✓		✗	✓	✗	✓	✗
No permanent impairment of soil functions through erosion on agricultural land	✓	✓	✓		✗	✓	✗	✓	✗
No impairment of water bodies and semi-natural habitats by washed-away soil material from agricultural areas	✓	✗	✗		✗				
Compensation of soil organic matter losses due to agricultural use of mineral soils.	✓	✓	✓		✗	✓	✗	✗	✗
Minimizing the loss of soil organic matter due to agricultural use of organic soils.	✓	✓	✓		✗	✓	✗	✗	✗
No permanent imapirment of soil functions, water and natual habitats by pollutants from agriculture.	✓	–	✓		✗	✓	✓	✓	✓
Substantial reduction of risks to humans, anmimals, plants and water bodies by pesticdes, fertilizers and other agricultural inputs.	✓	–	✗						
No permanent loss of soil biodiversity and activity due to agricultural soil use	✓	✗	✗						
Selection of SSM related SP-CP-targets									
By the SP-CP, the quality and quantity of the best Swiss arable soils will be permanently protected	✓	✓	✓		✗	✓	✓	✓	✓

Table 45 Responses by Switzerland to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X).Blank spaces correspond to either no response of an 'unknown' response.

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?
Selection of SSM related EGA-targets			
No impairment of soil fertility and [human] health due to inorganic or organic contaminants from agriculture	✓		✗
Input of individual contaminants from agriculture in soils is smaller than their output and degradation	✓		✗
Erosion on agricultural soils has to stay below threshold and prevention of talweg erosion	✓		✗
No impairment of soil fertility through erosion	✓		✗
No impairments of water bodies by washed-away soil material from agricultural soils	✓		
Avoiding permanent compaction of agricultural soils	✓		✗
Selection of SSM related CSA-targets			
Increase and maintain soil structure and fertility in general.	✓		
Targeted managament of SOM fosters C sequestration as well as the strive for an optimal SOC level.	✓		
Agriculture should become a net C sink. C sequestration by land use and land use change should at least compensate for C emissions.	✓		
Avoid N2O and CH4 emmissions as far as possible.	✓		

While there is clear policy intent across all identified policies, there is a need for increased scientific evidence to support these policies as well as a need for new research to develop measurable indicators for the following:

- Reducing impairment of water bodies and semi-natural habitats by washed away soil material from agricultural areas
- Reducing risks to humans, animals, plants and water bodies from fertilizers, pesticides and other agricultural inputs
- Losses of soil biodiversity and activity due to agricultural soil use
- All targets selected from the SSM-EGA section

Table 46 Swiss stakeholder comments on the various targets under the policies outlined in the survey instrument.

Policy	Stakeholder Identified Target	Stakeholder Comments
Swiss Soil Strategy	Avoidance of permanent compaction in agricultural soils	The STRUDEL project provides indicators for soil compaction, but the indicators are not yet considered in legislation. STRUDEL = Soil STRUcture Degradation Evaluation for Environmental Legislation
	No permanent impairment of soil functions through erosion on agricultural land	According to the soil protection ordinance the tolerable rate of erosion is 2 or 4 t/ha/a depending on soil depth. Only erosion risk (based on soil erosion modelling), not actual erosion is monitored. No indicator for the impairment of soil functions by erosion exists.
	Compensation of soil organic matter losses due to agricultural use of mineral soils	%C_{org} and C_{org}:Clay-ratio could be valuable indicators
	Minimizing the loss of soil organic matter due to agricultural use of organic soils	% C_{org} and lowering of organic soil surface level could be used as indicators
	No permanent impairment of soil functions, water and natural habitats by pollutants from agriculture.	Indicators and interpretation for organic and inorganic pollutants exists. For other substances, only limited knowledge exists. Not enough knowledge on impairment of soil functions.
	Substantial reduction of risks to humans, animals, plants and water bodies by pesticides, fertilizers and other agricultural inputs	Ongoing research for risk reduction of pesticides
	No permanent loss of soil biodiversity and activity due to agricultural soil use	Multiple suggestions for indicators exist.

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Environmental Goals Agriculture		Agro-environmental indicators (AUI) for some targets exist. However, they do not allow the assessment of the degree of target achievement.
Sector Plan Prime Crop Land Protection		Criteria for prime cropland are defined in the SP-CP (ARE, FOAG, FOEN and FONES, 2020).

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UK

Table 47 Responses by the UK to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X).Blank spaces correspond to either no response of an 'unknown' response

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?	Please specify indicator and unit if known	Is this indicator harmonised across EU?	Is indicator robust, reliable and statistically validated?	Monitoring Requirements -is a clearly defined monitoring review time period established?	Are reference (baseline) values and / or interpretation of indicators established?	Reporting Requirements - Are data available when needed and readily revised if required?
GREEN DEAL									
Emissions Trading System	✓	–	✓		✗				
Member State targets to reduce emissions in sectors outside the Emissions Trading System	–	–	✗		✗				
Regulation on land use, land use change and forestry to include removals from land, land use change and forestry.	✓	✓			✗		✗		
Limit/exclude Carbon Leakage where incoherence at global scale is found	–	–	✗		✗		✗		
Climate change Adaptation ustilising nature-based solutions	–	✓			✗		✗		
CAP									
Enhanced Conditionality	–				✗		✗		
Eco-schemes	–	–			✗		✗		
Farm Advisory Service	–		✗		✗		✗		
Agri-environment-climate measures and investments	✗	–			✗		✗		

Table 48 Responses by the UK to the horizon scanning activity in which specific questions about targets within the listed policies were responded to with a scale of agree/yes (green tick), partly agree (yellow bar) or disagree/no (red X).Blank spaces correspond to either no response of an 'unknown' response.

	Policy intent is clearly defined	Scientific evidence base to support policy exists	Does a measurable results data indicator exist?	Please specify indicator and unit if known	Is this indicator harmonised across EU?	Is indicator robust, reliable and statistically validated?	Monitoring Requirements -Is a clearly defined monitoring review time period established?	Are reference (baseline) values and / or interpretation of indicators established?	Reporting Requirements - Are data available when needed and readily revised if required?
FARM TO FORK									
Reduction by 50% of the use and risk of pesticides	–	✓	–		✗		✗		
Reduction by at least 20% of the use of fertilizers	✓	✓	✓	Nitrogen rate of fertilization	✗	–	✗		
A reduction by 50% in sales of antimicrobials used for farmed animals and aquaculture	✓	✓	–		✗		✗		
Reaching 25% of agricultural land under organic farming	✓	✓	–		✗		✗		
BIODIVERSITY STRATEGY									
Binding targets to restore damaged ecosystems and rivers.	–	–			✗		✗		
Improve the health of EU protected habitats and species	–	✓			✗		✗		
Bring back pollinators to agricultural land	–				✗		✗		
Reduce pollution		✓			✗		✗		
Green our cities	–				✗		✗		
Enhance organic farming and other bio-diversity friendly farming practices	–	✓			✗		✗		
Improve the health of European forests.					✗		✗		
Transform 30% of Europe's lands and seas into protected areas		–			✗		✗		
Bring back at least 10% of agricultural area under high-diversity landscape features.					✗		✗		

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The responses above indicate that there is some need for clearer definition of policy intent as well as a need for more supportive scientific evidence especially with respect to CAP and the Biodiversity Strategy. New research needs to be done to develop measurable indicators for the following targets:

- Member state targets to reduce emissions in sectors outside of the emissions trading system (GD)
- Limit/exclude C leakage where incoherence at global scale is found (GD)
- Farm advisory service (CAP)

4.2.4 Summary of priority needs for new research

This section identified several needs for new research including the types of tools that need to be developed, areas where there are gaps in the scientific knowledge and new ways in which existing data can be repurposed. Findings from the forums highlighted the need for the definition and development of assessment tools and indicators for ecosystem services at both the EU level and the national level. The domain of ecosystem services continues to be in need of further elucidation before it can be efficiently incorporated into policy development. Many of the survey responses indicated that there was insufficient scientific evidence to support the targets within the Biodiversity Strategy and that these targets also require greater clarification of their intent.

The EU forum also revealed the need for risk management tools, and multifunctional plans capable of addressing multiple targets simultaneously. Across all forums there was a need expressed for better understanding and development of tools to foster behavioural change among famers as well as the public.

Among the survey instrument responses there were several targets that were repeatedly identified as requiring the development of a measureable indicator for assessing target realisation. The most common targets identified to have this issue are:
Limit/ exclude C leakage where incoherence at a global scale is found (Green Deal)
Climate change adaptation utilizing nature based solutions (Green Deal)
Farm advisory service (Common Agricultural Policy).
Findings in this section also reiterate the need for new research into the domain of soil biodiversity and ecosystem services and the development of tools and indicators to assess and measure these components so that they can be included in policy development going forward.

4.3 Priority needs for enhanced access to available results and knowledge

4.3.1 Priority needs for enhanced access expressed at EU Forum

EU level stakeholders also expressed some of the following needs to increase the accessibility of available knowledge and results (Fig. 16).

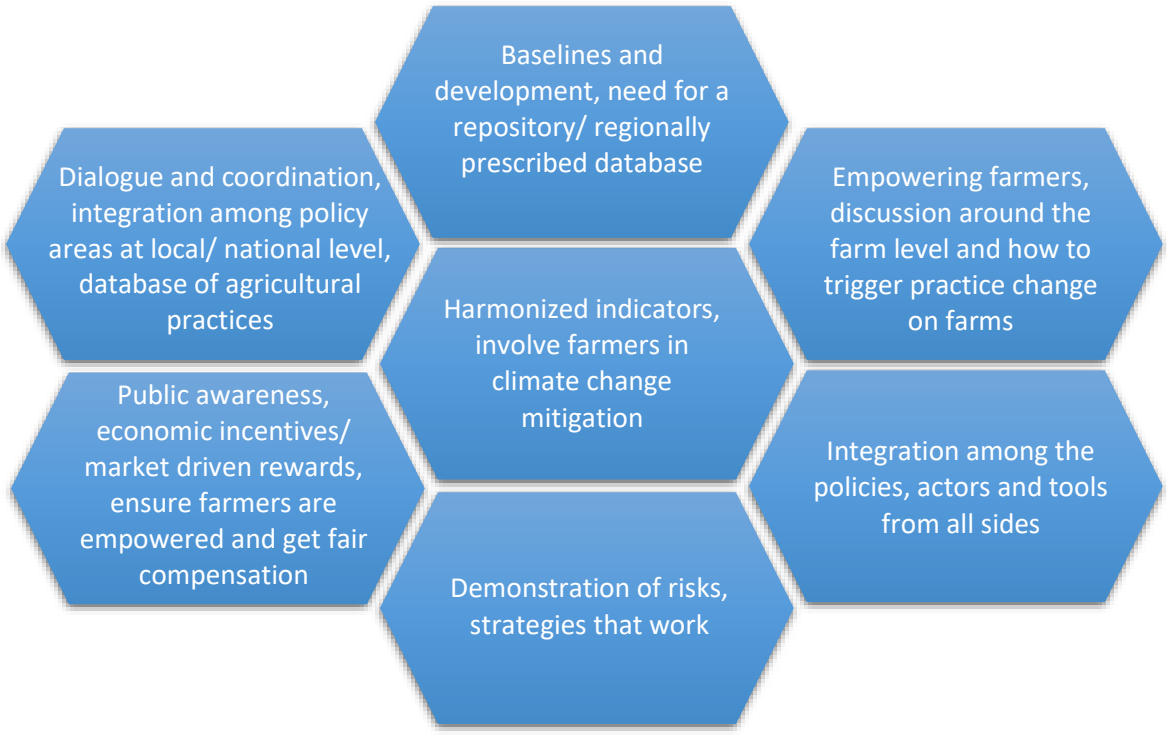

Figure 14 Key needs for increased access to knowledge expressed by stakeholders during the EU forum

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4.3.2 Priority needs for enhanced access expressed at the National Forums

Ireland

Table 49 Responses from Irish stakeholders that highlight needs for better access to results and shared knowledge within the identified policies.

Policy	General Comments	Implementation/ Adoption	Monitoring/ Evaluating/ Reporting
CAP			Common definitions/ terminology in systems between regulators and advisors
			Mapping, modelling & recording systems and capabilities
Climate Action Plan		Cross sector communication/ responsibility to ensure that policies reach farmers	Common metrics, co-operation between policies and agencies
Green Deal			Work sharing and integration
Biodiversity Strategy	Knowledge gaps are significant between the science and the farmer/public		
	Need for translation of the scientific knowledge		

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Italy

Table 50 Responses from Italian stakeholders that highlight needs for better access to results and shared knowledge within the identified policies.

EJP Soil Domain	General Comments	Implementation/ Adoption	Monitoring/ Evaluating/ Reporting
Climate Change Adaptation		Knowledge repositories and more exchange are needed	
		Need for greater integration among various existing projects, which are too fragmented	
Ecosystem Services		Lack of a network of soil observers in the regions	Standardise activities in the various regions
			Promote the use of standardised indicators common to the different policies (e.g. use the same tools when approving livestock farms, monitoring and evaluation of funds release)
Avoid Land Degradation	Promote the FAST project as a tool for homogenous management between regions and as a repository of applied knowledge	Lack of a network of soil observers in the regions	

Increasing access to results and available knowledge was a key area of focus within this member state's national forum. Several potential instruments to meet the needs within this area were discussed including the establishment of a National Soil Hub, which should "encourage an agro-ecological transition and formulate concrete proposals for actions to be implemented at a national level". The creation of a "Soil Observatory" was also put forward as an instrument to increasing sharing of data at a national level. This soil observatory "should include not only pedologists, but also experts on other soil related thematic areas, such as environment, ecology and agricultural economics". It would also

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work to translate and transfer scientific knowledge as well as policies at EU level to meet the needs at a national and local level.

Latvia

Table 51 Responses from Latvian stakeholders that highlight needs for better access to results and shared knowledge within the identified policy targets.

Policy & Target	Implementation / Adoption	Monitoring/ Evaluating/ Reporting	Scientific Data & Knowledge Needs
General Comments	New technologies for implementation must be understandable and accessible		Increased knowledge transfer between stakeholders and institutions involved so that the results of research can be passed on to farmers
	Use of demonstration farms, seminars, interest and focus groups and websites		
	Ensure the use of user friendly language and terminology for distributed information		
CAP – Reducing nutrient loss without reducing soil fertility		Public authorities need access to results for soil analysis to be able to carry out monitoring and data processing. The policy and system for data sharing needs improvement.	
GD- Reduction of greenhouse gases to zero net emissions by 2050			Creation of a specific system that would ensure the transfer of information between institutions and promote cooperation

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4.3.3 Priority needs for enhanced access expressed in the Survey Responses

Across all respondents, there was a clear need for greater harmonization of indicators, and metrics across the EU and even at a national level in some cases, due to regional differences, with respect to policy instruments. This harmonisation is key to increased accessibility to the results and data that exists and also for using and comparing results within and between regions, countries and at EU level. A lack of standardized methods surrounding policy instruments was also indicated as a contributor to gaps in policy realisation. This suggests that greater standardization of methodologies would improve access to shared knowledge and the transfer of that knowledge at all levels and between participating bodies.

4.3.4 Summary of priority needs for enhanced access to available results and knowledge

Consistently and clearly, there has been a great need for data and process harmonisation throughout this report. The policy forums highlighted this need as being necessary to allow better access to results and sharing of knowledge. There was a call for databases to be created both at the European and at national levels to allow for this increased access to data that is essential for developing policies that are specific, well defined and based in scientific evidence. Two of the three national forums resulted in stakeholders suggesting methods by which these databases could be created and improved as well as the information they should contain and the persons who should be included in their creation and operation e.g. creation of a Soil Observatory in Italy which “should include not only pedologists, but also experts on other soil related thematic areas, such as environment, ecology and agricultural economics”. Additionally stated in the forums was the need for “common definitions, metrics and tools” this was further supported at a member state level with almost all respondents indicating a lack of standardized, harmonized indicators with which policy targets can be robustly assessed across the EU.

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4.4 Co-innovation across EJP SOIL Domains

Survey responses from stakeholders from all participating countries were grouped and analysed based on the EJP SOIL domains. The frequency in the tables below indicates the number of times an instrument was suggested by multiple different stakeholders. The ranking of the types of instruments was calculated by finding the mean ratings for each instrument across all responses for each domain.

4.4.1 Climate Change Mitigation

Table 52 Summary of the instruments suggested for policy development within the EJP SOIL domain of climate change mitigation.

Suggested Instrument	Freq.	Readiness	Type of Instrument	Possible Measureable Indicators	**EU Harmonised**	Robust
Carbon market that includes C sequestration in soils	4	Somewhat	Mixed - Market, Voluntary, Mandatory	kg C, GHG	No	
				GHG emissions, CRF reporting	Yes	Yes
				€/to CO2	Yes	Yes
Carbon Farming	2	Somewhat/ Not at all	Mixed - Voluntary, Market, Mandatory	CO2 Eq	No	Yes
Peatland preservation/ restoration	4	Somewhat/ Ready	Voluntary/ Mandatory	Rewetted area	No	Yes
				Thickness of peat soils	No	Yes
Sustainable land management measures	2	Ready / Not at all	Voluntary	Grazing livestock/ livestock units	Yes	Yes
Advisory service, trainings, best practice examples for farmers	1	Somewhat	Voluntary	Number of participants	No	No
Carbon footprint labelling (particularly regarding fertilization and livestock production)	1	Somewhat	Voluntary	CO2eq/kg of product	Yes	Yes

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Agroforestry/tree and hedge planting. Nitrogen **Fertiliser** reductions	1	Somewhat	Mixed			
Preparation of a report on carbon sequestration in Swiss soils	1	Don't know				
Bonus-malus system	1	Somewhat	Voluntary			
Stricter national targets and regulations	1	Not at all	Mandatory			

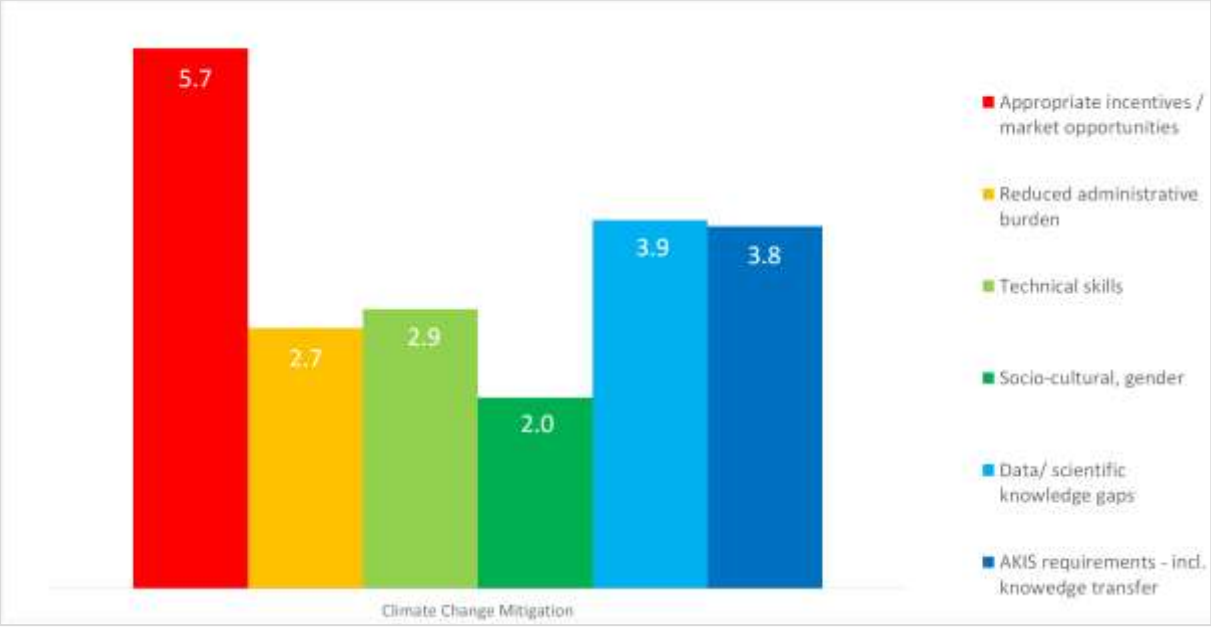

Figure 15 Average ranking across all respondent countries of the importance of the types of instruments for policy development within the EJP soil domain of climate change mitigation. A value of 1 represents least important and a value of 6 represents most important.

There were a significant number of suggested instruments for co-innovation of policy within the domain of climate change mitigation. Among them, a carbon market and peatland restoration were most frequently proposed, with four different respondents suggesting both. Carbon farming was also more frequently suggested within this domain. Overall, most of the suggested instruments were at most, somewhat ready to be implemented and in general, the suggested instrument types were mixed.

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When looking at the ranking of possible instrument types within this domain (Fig. 17) Appropriate incentives / market opportunities has a ranking of 5.7, a clear indicator that these types of instruments are considered very important for meeting policy targets within this domain. This is also reflected in the suggested instrument types, as market instruments are one of the more common options (Table 52). Also of some significance with ratings of 3.8 and 3.9 were AKIS requirements and Data / scientific knowledge gaps, respectively. We see a clear need for scientific underpinning of instruments within this domain and an associated importance placed on the transfer of that scientific knowledge.

Table 53 Stakeholder comments associated with specific instruments that were suggested within the EJP soil domain of climate change mitigation.

Suggested Instrument	Stakeholder Comments
Measures against land abandonment - e.g. to protect grassland in slopes/ mountain areas	There is an ongoing discussion about ruminant and GHG emissions, but under grazed land carbon sequestration is higher and with moderate, seasonal grazing the erosion risk can be reduced.
Identify and foster sustainable agricultural (or other) management of organic soils by agricultural and/or environmental policies	Could as well be mandatory instead of voluntary. Was also mentioned in FOEN (2020) as measure 'AP2-b3 Protection and regeneration of peat and organic soils'.
Preparation of a report on carbon sequestration in Swiss soils	As part of the fulfilment of the parliamentary postulate of MP Bourgeois (19.3639), a report is to be prepared on the possibilities of carbon sequestration in the various soils of Switzerland. It is expected that the report will identify research needs and that implementation measures proposed in it can only be tackled in the longer term.

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4.4.2 Climate Change Adaptation

Table 54 Summary of the instruments suggested for policy development within the EJP soil domain of climate change adaptation.

Suggested Instrument	Freq.	Readiness	Type of Instrument	Possible Measureable Indicators	EU Harmonised	Robust
Restorative/ Regenerative agriculture/ Agroforestry	3	Ready/ Somewhat	Voluntary	Soil cover / intensity of soil work	No	
Selection/ breeding / optimized use of adapted plants and animals	2	Somewhat	Market			
Laws, regulations, removing hindering policy	2	Somewhat/ Not at all	Mandatory			
Site-adapted advice, trainings, demonstrations for good practices	3	Somewhat	Voluntary	Number of participants	No	No
SOC management	1		Mandatory	SOC	No	No
Drainage systems	1	Somewhat	Voluntary			
Conditions for weather insurance CAP (conditionality, eco-schemes, GAEC)	1	Not at all	Market			
Concept of Implementation for national soil survey	1	Don't know				

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Careful use of soil and water	1	Don't know				
Expansion of monitoring and early warning	1	Don't know				
Development of Markets for changing crop types. Advisory support e.g. ASSAP	1	Fully ready to somewhat ready	Voluntary/ Market			
Cooperative mutual insurance funds connected to activities for CC adaptation performed by farmers	1	Somewhat	Voluntary	No. of insured persons		Yes
Buffer strips / perennial crops	1	Ready	RDP Scheme			

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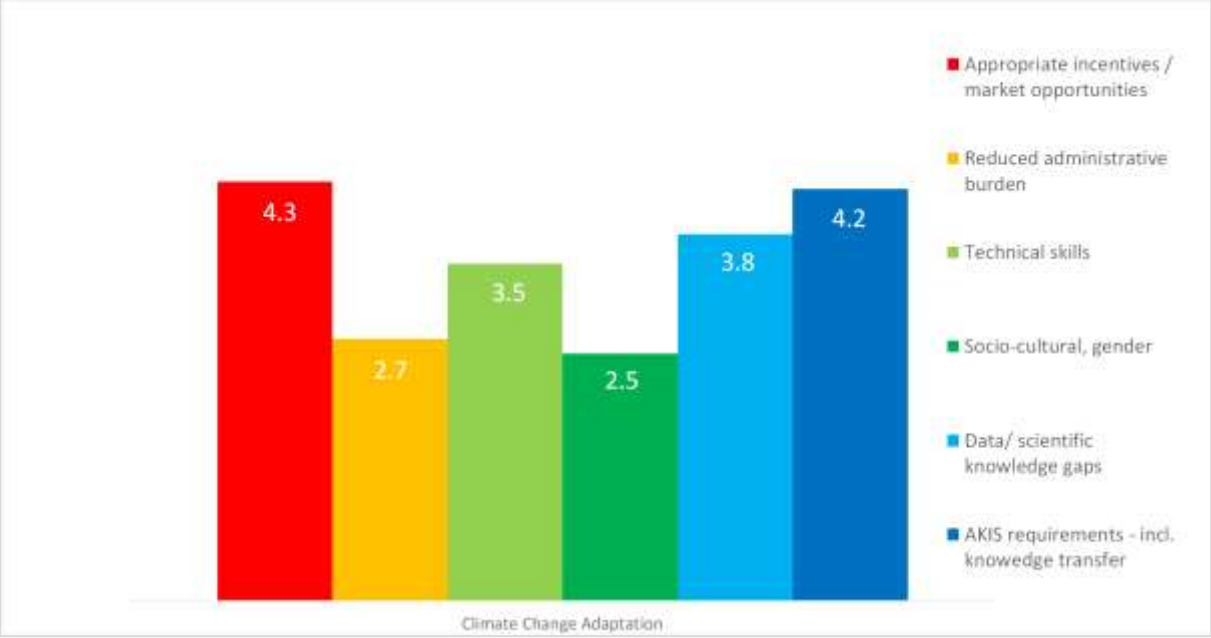

Figure 16 Average ranking across all respondent countries of the importance of the types of instruments for policy development within the EJP soil domain of climate change adaption. A value of 1 represents least important and a value of 6 represents most important.

The domain of climate change adaptation is a challenging one, as it requires thoughtful strategies that are not merely reactionary. The most commonly suggested instruments included regenerative agricultural practices, site-specific advice, and knowledge demonstrations (Table 54). Other instruments suggested by multiple respondents were the optimised use of adapted plants and animals and the removal of laws and regulations that hinder policy within this domain. The types of instruments were predominantly classed as voluntary or mandatory.

Considering the ranking of the importance of different instruments, appropriate incentives once again ranked highest with a score of 4.3 followed closely by AKIS requirements – including knowledge transfer with a score of 4.2. Rated third with a score of 3.8 was Data/ scientific knowledge gaps (Fig. 18). This indicates a slight shift from the previous domain of CCM, where the importance was on existing market structures and systems, to an increased importance on scientific research and knowledge transfer. This suggests that perhaps more clearly communicated scientific data needs to be made available for policy tool development as well as the need for research into instruments that can allow for adaptation rather than mitigation to the global issue of climate change.

Table 55 Stakeholder comments associated with Swiss CC Adaptation Strategy instruments that were suggested within the EJP soil domain of climate change adaptation.

Swiss CC Adaptation Strategy Instruments	Stakeholder Comments
Concept of Implementation for national soil survey	The aim of this measure is to develop an implementation concept that will enable the federal government and the cantons to map the qualities and sensitivities of Switzerland's soils using state-of-the-art technology, including the compilation of the necessary financial resources and infrastructure. The goal is to collect the necessary information for a sustainable use of Swiss soils in a timely

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	manner, taking into account the expected climate changes.
Optimized use of adapted plants and animals including handling of harmful organisms	This set of measures includes: Identification of crops and cultivation systems in arable and grassland farming that are better adapted to future conditions (e.g. higher temperatures, heat, water scarcity) Integration and investigation in cropping systems, including possibilities for crop management. Applied research on new systems like agroforestry. Testing of options to extend crop rotation with a view to a longer growing season.
Careful use of soil and water	This set of measures includes: Investigate possibilities and limits to improve infiltration and storage capacity, prevent erosion and avoid compaction. Experimental design and testing of integrated management systems combining adapted crop rotations, variety selection, tillage and other measures to improve the water use efficiency of crops. Producing efficient irrigation systems and strategies. Possibilities of controlling the soil water balance with drainage systems depending on the available precipitation (water table management) Further development of existing [...] production systems, especially for soil and humus sparing cultivation systems.
Development of basics for site-adapted management	This set of measures includes: Preparation and modelling of climate-sensitive spatial information relevant for management and presentation on maps analogous to erosion risk and watercourse connection: e.g. updating and refinement of soil suitability map, delimitation of soils sensitive to compaction, recording of organic soils, regional water balancing, crop-specific climate suitability assessment, phenology, pest distribution, corridors for climate-sensitive species, heat days.
Modelling of changes due to climate change (scenarios). Risk analyses.	Merging of information in the Web-GIS. Linking with plot boundaries. Designation of risk areas. Development of concepts for assessment and strategies for optimizing site suitability. Further

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	development of good professional management practice. Development of a web-based system for interactive simulation of changes and adaptation possibilities. Design of site-dependent management requirements.
Expansion of monitoring and early warning	This set of measures includes: Gathering of existing products and information, analysis of needs and identification of gaps in monitoring and early warning related to agriculture. Enhancement of existing monitoring systems in order to assess the climate change impacts on agriculture and adaptation of management. Generation of current status reports and forecasts for relevant indicators (e.g. soil moisture measurement network, pest distribution bulletin), if necessary through measurement and reporting campaigns involving practical experience. Establish a central national coordination, administration and publication office for management-relevant climate and soil information (MeteoSwiss, Agroscope, FOEN, cantons). Definition of critical threshold values. Development of regionally differentiated traffic light systems and generation of current management recommendations (e.g. with regard to vehicle access, fertiliser application, use of pesticides, irrigation). Development of decision-making aids for the short-term issuing of decrees (e.g. drought checklist). This will (have to) happen by itself (in view of the long-term economic consequences for individual farms), but there is a need for information/training/advice and cooperation to tackle the challenge and to achieve good practices.

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4.4.3 Avoiding Land Degradation

Table 56 Summary of the instruments suggested for policy development within the EJP soil domain of avoiding land degradation.

Suggested Instrument	Freq.	Readiness	Type of Instrument	Possible Measureable Indicators	EU Harmonised	Robust
Add & define indicators/ limit values for soil quality into legislation	2	Somewhat	Mandatory	Indicators available from STRUDEL project		
Encourage beneficial management practices and phase out non-beneficial practices at a site specific level	2	Somewhat	Mixed - Market, Mandatory, Voluntary			
Encourage alternative agriculture methods e.g. organic, agro-forestry, precise agriculture	4	Ready/ Somewhat	Mixed - Mandatory / Voluntary	Area (ha),	Yes	Yes
				Min. /Max. trees per ha	No	
Establish tools to asses erosion, Land Degradation Neutrality indicators	2					
Independent advisory service for sustainable soil management	3	Ready/ Somewhat	Voluntary			
Decision support tools for farmers e.g. simulation models	2	Somewhat	Voluntary			
Agri-environment schemes/ incentives	2	Ready	Voluntary & Mandatory	ha	Yes	Yes
				ha	No	

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Economic incentives for improving soil quality	2	Ready/ Somewhat	Market & Voluntary			
Certification schemes targeting deforestation	1	Somewhat	Market			
Nutrient cycling between livestock and arable farms; between regions	1	Somewhat	Mandatory for farms exceeding a nutrient level, voluntary for uptaking farms	N / P kg / ha - could be linked to nutrient management tool	Partly (Nitrates directive)	Yes
Enhanced Conditionality	1	Somewhat	Mandatory	Ecosystem condition	Yes	Yes
Define indicators and limit values for SOC of mineral soils in legislation	1	Somewhat	Mandatory	C_{org}		
Regulations regarding tolerable weights of farming equipment to limit soil compaction	1	Somewhat	Mandatory			
Training programs for pedological construction support	1	Somewhat	Voluntary			
Linking CAP Payments to SOC levels	1	Not at all	Mandatory	SOC Levels	Yes	Yes
Permanent grasslands	1	Ready	RDP Scheme			

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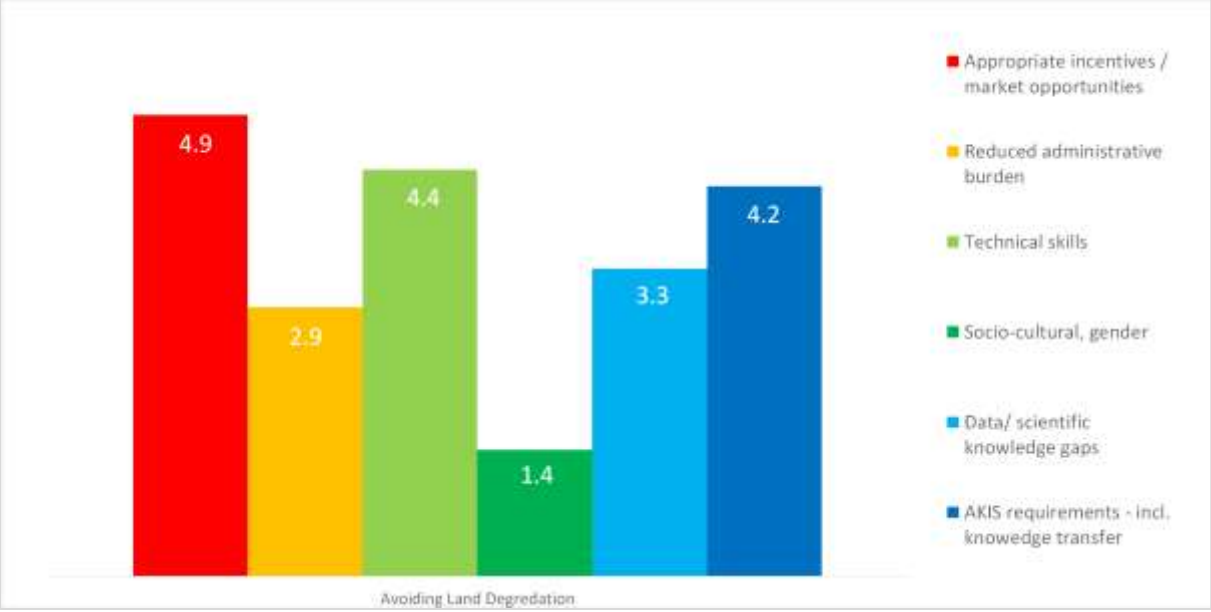

Figure 17 Average ranking across all respondent countries of the importance of the types of instruments for policy development within the EJP soil domain of avoiding land degradation. A value of 1 represents least important and a value of 6 represents most important.

Many of the instruments within the domain of avoiding land degradation were suggested by multiple respondents. Four respondents suggested the promotion of alternative agricultural methods as a ready/ somewhat ready instrument that could be implemented with a mixture of voluntary and mandatory measures (Table 56). Another common suggestion was an independent advisory service for sustainable soil management which was described as a voluntary instrument in a state of partial readiness. This domain had the greatest number of suggested instruments and so there is great potential for further discussion and development around the foundation provided by this pool of suggestions.

Appropriate incentives was ranked the most important instrument type for this domain, with a ranking of 4.9, followed closely by technical skills (4.4) and AKIS requirements (4.2). Data/ scientific knowledge gaps was ranked the fourth highest with a score of 3.3 (Fig. 19). This domain requires proper incentives backed up by sufficient knowledge transfer and the proper technical skills to put the proposed instruments into place.

Table 57 Stakeholder comments associated with specific instruments that were suggested within the EJP soil domain of avoiding land degradation.

Suggested Instrument	Stakeholder Comments
Establish a network of independent farm advisors on sustainable soil management that can provide farm-specific advice with a close link with research and policy for optimal transfer of knowledge (in both directions)	Monitoring programmes needed to monitor results and impact on soil quality, avoided degradation For soil erosion! (but based on modelling see (Cantreul et al., 2020) Input measures taken by farmers could be improved
Encouraging certain practices, phasing out other practices, dependent on the region and the soil challenge on the one hand, the	Difficult to get a comprehensive view of the situation with one (and only one) indicator.

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market/consumer must also be prepared to pay for additional efforts/results; if soil care/work on soil care is not respected, negative market-economic consequences should be considered in the long run.	
Certification schemes targeting deforestation	Soy, palm oil certification schemes target deforestation outside EU, while in the forest sector there are also certifications for EU forestry
Advisory Platform at European level for soil advice	This idea came up in the EIP Agri discussion - some expressed the need to foster cross-border knowledge exchange and to have one place with a repository of promising tools / measures
Agro-forestry	Should include trees in pastures; the risk to loose direct payments and/or the status of agriculture land due to the planting of trees is a huge obstacle for adoption of this practice that at the same time benefits soils, mitigates climate as well as can be a powerful climate adaptation measure.
Tools to assess actual soil erosion after rainfall events (e.g. by remote sensing) in areas with high erosion risk	This tool could improve the execution of existing policies. This instrument could increase the effectiveness of policies that limit the tolerable erosion rate.
Identify and eliminate economic incentives that limit soil protection from erosion	This instrument could increase the effectiveness of existing policies that limit the tolerable erosion rate.
Reassess legislation for registration and application of potential soil pollutants with a risk-based approach	This could apply to pesticides, fertilizers, plastic, etc. For pesticides, research is ongoing in Switzerland
Define indicators and limit values for SOC of mineral soils in legislation	Reference values could be site-specific and related to clay content
Direct payments for improving and maintaining SOC stocks	Humus balance calculations or measurements
Add additional soil quality indicators in legislation (e.g. SOC levels and soil structure)	At the moment quantitative soil quality indicators and threshold values only exist for organic/inorganic pollutants and soil erosion

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	rates. For compaction/soil structure and additional pollutants research is ongoing.
Decision support tool for farmers to assess the risk of soil compaction	The Terranimo Model could be used for this.
Define indicators and limit values for soil structure in legislation	The STRUDEL project should provide indicators and guide values.

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4.4.4 Ecosystem Services

Table 58 Summary of the instruments suggested for policy development within the EJP soil domain of ecosystem services

Suggested Instrument	Freq.	Readiness	Type of Instrument	Possible Measureable Indicators	EU Harmonised	Robust
Payment/ Compensation for ecosystem services	6	Not at all / Somewhat	Mixed - Voluntary, Market	Carbon storage, number of participating regions, dependant on service		
Harmonise and simplify legislation for application of inputs into soil (e.g. buffer strips for inputs such as feritilizer and pesticides)	2	Somewhat	Mandatory			
Artificial wetlands	3	Somewhat/ Ready	Mixed - Voluntary, Mandatory, Market, RDP Scheme	N & P balance (kg/ha). Area (Ha or %) in EFA or Habitat	No	No
				N & P loss	Yes	Yes
Agri-environment-climate measures	1	Ready	Voluntary	(ha)	No	
Assessment tools	1	Somewhat	Mandatory	Supply potential	Yes	Yes
Database / Monitoring of soil organisms	1	Not at all	Mandatory	Biological soil quality indicators	No	Yes
Including nature based solutions in EU and national policies	1	Somewhat	Voluntary			

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Agroforestry	1	Somewhat	Mandatory			
Laws / regulations	1	Not at all	Mandatory			
National regulations implementing ND and Directives reg. Natura2000	1	Ready	Mandatory			

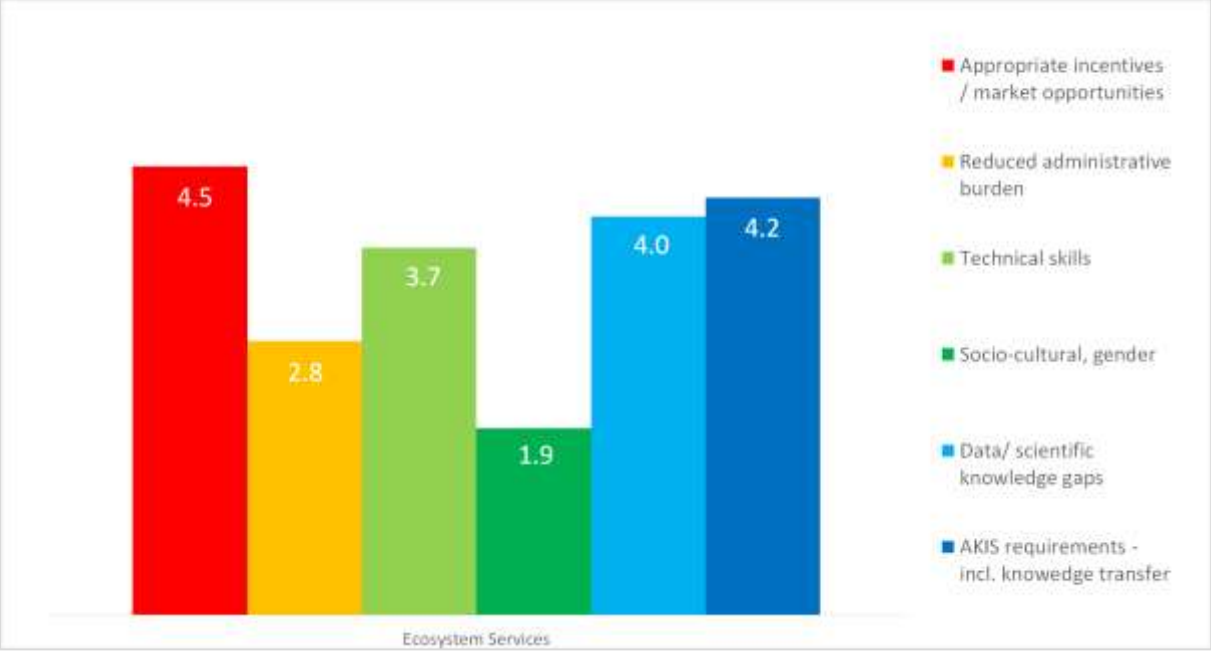

Figure 18 Average ranking across all respondent countries of the importance of the types of instruments for policy development within the EJP soil domain of ecosystem services. A value of 1 represents least important and a value of 6 represents most important

Ecosystem services requires further clarification in terms of the ability to accurately measure and monitor these services. Six respondents suggested paying for ecosystem services as a potential instrument for policy development (Table 58). However, this instrument was stated to be in a state of "not ready"/ "somewhat ready" and possible measureable indicators are "dependant on the service". So while there is a lot of backing of this instrument, greater definition and clarification is still needed. Other common suggestions included artificial wetlands as an instrument to improve water quality and amending regulations that govern the application of inputs into the soil.

The importance of instruments within this domain is very similar to the previous domain with "Appropriate incentives" ranking as most important (4.5) followed by "AKIS requirements" (4.2) and then by "Data/ scientific knowledge gaps" (4.0) (Fig. 20). This indicates a strong need for tangible

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markets backed up by scientific evidence and knowledge transfer to enable the development of functional policy instruments within this domain.

Table 59 Stakeholder comments associated with specific instruments that were suggested within the EJP SOIL domain of ecosystem services.

Suggested Instrument	Stakeholder Comments
Payment for Ecosystem Services	The biggest obstacle in the agriculture sector seems to be the WTO rules (income foregone / additional cost) that hampers rewarding farmers from generating income / profit from provision of ES under CAP / private schemes are possible and some are under development.
Problem/challenge is still very vague. Imposing certain "baseline requirements"; or imposing requirements regarding the result-oriented work on the challenge of achieving these baseline requirements	Difficult to get a comprehensive view of the situation with one (and only one) indicator.

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4.4.5 Food Security

Table 60 Summary of the instruments suggested for policy development within the EJP SOIL domain of food security

Suggested Instrument	Freq.	Readiness	Type of Instrument	Possible Measureable Indicators	EU Harmonised	Robust
Local protein vegetable crops	2	Somewhat	Mixed - Voluntary, Mandatory, Market	Area under crops (ha)/ Produce sold total T	No	Yes
Encourage/oblige sustainable soil management practices via incentives	4	Somewhat	Mixed - Mandatory, Market			
Reduce and avoid soil sealing	1	Somewhat	Mandatory	ha/ day or ha/ yr	Yes	Yes
Production quota in the EU	1	Ready	Mandatory			
Revitalising abandoned alpine meadows	1	Somewhat	Voluntary	Area of alpine meadows (ha)	Yes	Yes
Contingency plan for ensuring food supply and food security	1		Voluntary	FAO, WFP indicators		
Legal certainty for farmers: access to land, correct price (= price transparency, unfair trading practices, position in the chain)	1	Somewhat	Market & Government			
Binding thresholds CAP	1	Somewhat	Mandatory			

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Create a soil quality index and maps of soil functions as well as soil quality index points for spatial planning	1					
Protection of fertile soils	1	Ready	Mandatory			
Alternatives to the area based direct payments	1	Somewhat	Mandatory	Crop diversification/ soil cover over the year/ grazing livestock		
CAP investment instruments and education instruments	1	Ready	Voluntary			

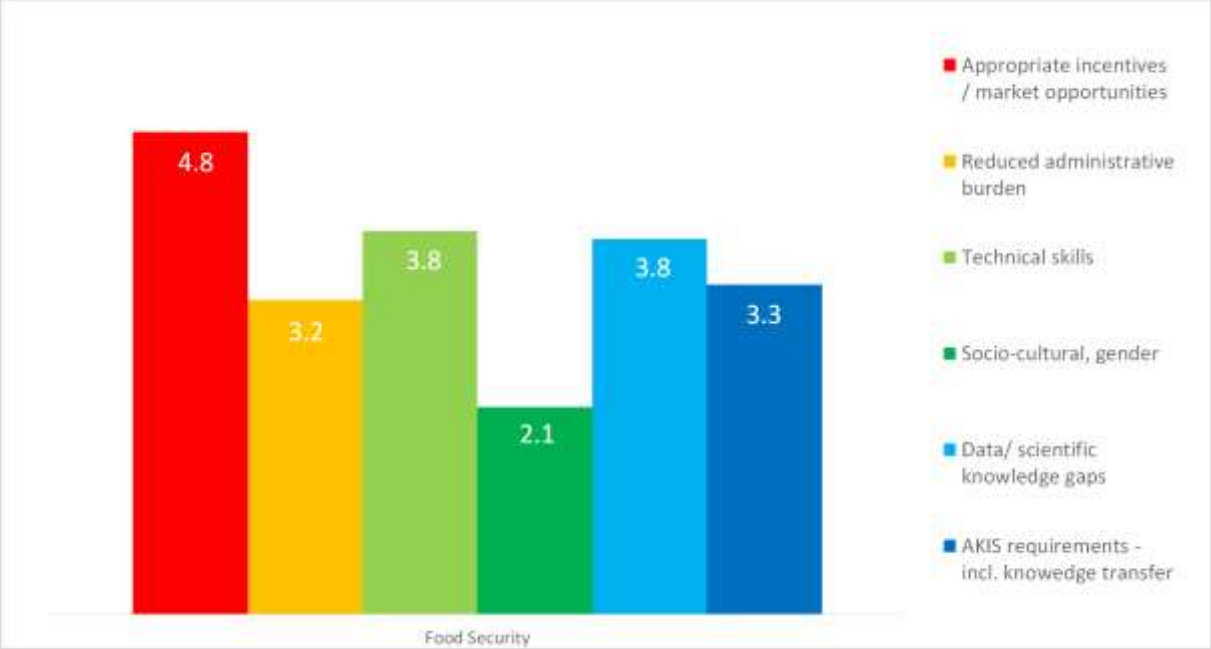

Figure 19 Average ranking across all respondent countries of the importance of the types of instruments for policy development within the EJP soil domain of food security. A value of 1 represents least important and a value of 6 represents most important.

The most commonly suggested instrument in this domain was the encouragement of sustainable soil management practices via incentives (Table 60). This instrument suggested by four respondents was said to be in a somewhat ready state and should use a mixture of market and mandatory approaches. Another common instrument was the use of local protein vegetable crops, which was also defined as

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being in a somewhat ready state and suggested the use of mixture of market and mandatory instruments.
Correspondingly, Appropriate incentives was ranked as the most important type of instrument in this domain with a ranking of 4.8, followed by Data / scientific knowledge gaps with a score of 3.8 (Fig. 21). Clearly more research needs to be done within this domain to identify possible indicators and provide evidential support for the development of policy instruments. Technical skills and AKIS requirements were also considered important, indicating the need for knowledge transfer and development of tools and methods needed to support policy within this domain.

Table 61 Stakeholder comments associated with specific instruments that were suggested within the EJP SOIL domain of food security.

Suggested Instrument	Stakeholder Comments
Promoting certain practices, phasing out others (which is in the "general interest"); the importance of clear communication, of working together towards the implementation of "good practices"; in the long run, negative market-economic consequences should be considered when soil care/work on soil if food safety is not respected.	Difficult to get a comprehensive view of the situation with one (and only one) indicator.
Create a soil quality index and maps of soil functions as well as soil quality index points for spatial planning.	A soil quality index for spatial planning is known in Stuttgart (Germany) and was tested for Switzerland within the national research program 68 on the sustainable use of soil as a resource. The soil quality index points should foster the assessment of soil quality in spatial planning and divert soil sealing from "high quality soils".

4.4.6 Summary of co-innovation instruments within EJP Soil Domains

Across all domains appropriate incentives was consistently ranked as the most important instrument for policy development, indicating the emphasis and need for fair compensation and rewards for policy implementation. Other commonly highly rated instruments were AKIS requirements and data and scientific knowledge. Technical skills was ranked as high as second within the domain of avoiding land degradation. The instruments of socio-cultural & gender barriers and bureaucratic burden were generally of very little importance across all domains.

Certain instruments were also frequently suggested within each domain by a number of different stakeholders. The most commonly suggested instrument for each domain is listed below.

- Climate change mitigation – Carbon market,
- Climate change adaptation – Restorative/ Regenerative agricultural methods,
- Avoiding land degradation – Alternative agricultural practices,
- Ecosystem services – Paying for ecosystem services,
- Food security – Sustainable soil management practices.

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5. Conclusion

The key information gathered from different policy stakeholders from a range of sources and levels (regional, national and EU) contained in this deliverable highlights many significant soil policy related needs that exist as well as some of the possible instruments and methods that can be used to address these needs.

The knowledge needs highlighted included a need for increased scientific evidence to support policy targets, specifically those that may be relevant for the EU Biodiversity Strategy 2030. The need for the transfer of knowledge from the scientific domain into the policy domain with an emphasis on the cross collaboration between institutions and countries was highlighted. Data harmonisation and uniform simplified reporting that allows end users to understand the information and implement the knowledge were underscored as key requirements to facilitate knowledge transfer. Knowledge needs were also identified surrounding the development and implementation of on-site soil management strategies with the mention of needs for on-site demonstrations, risk assessment tools and dissemination of the evidence supporting the management strategies developed. These knowledge needs came to the fore repeatedly throughout the EU and National level forums.

The scientific knowledge and data gaps identified were also explored in greater depth during forum discussions and in the stakeholder survey comments. This gave rise to needs for new research e.g. need for the development of measureable indicators for soil biodiversity and ecosystem services, as well as standardized methods for their measurement, calculation and reporting across the EU. A universal need for more scientific evidence to support policy targets across all the emerging soil related policies included in this report was specified.

A lack of harmonization, communication and cross-country collaboration were the main limiting factors that reduced access to available results and knowledge. Thus, by addressing these issues and introducing systems for the collection, collation and distribution of results and knowledge, access to available results and knowledge that currently exists can be increased.

Across all three areas: priority knowledge needs, needs for new research and needs for enhanced access to available results and knowledge, the requirement of appropriate incentives was very dominant. Inappropriate incentives (e.g. monetary reward for farmers) was weighted as the most significant barrier to policy realisation more than 50% of the time. This was further emphasised in the co-innovation section of the report. Within this section, appropriate incentives was consistently the instrument ranked most important for policy development, regardless of the domain. This clearly reinforces the necessity of ensuring that incentives are vetted on their suitability for targets and their ability to sufficiently encourage policy implementation by end users.

The information contained in this report represents an initial summary of policy needs and the current state of the art on policy stakeholder requirements. This is especially useful going forward as it will help to enable research focus on these policy needs across the areas identified by the various policy stakeholders. Importantly, it highlights entry points to align EJP SOIL with the needs of policy stakeholders, allowing a move towards a strengthened science to policy interface.

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6. Appendix

6.1 Assumptions and methods Section 4.1

When only policies were analysed by the respondents (Ireland, Latvia, UK) the most related soil challenges were assigned to them. In cases where multiple soil challenges could be applied to a single policy the most relevant soil challenge was chosen via consultation with the respondent from the respective member state and this main soil challenge was used to create the respective graph.

Table 62 Soil challenges assigned to represent the policies identified by member states.

Identified Policy	Assigned Soil Challenges	Main Soil Challenge Used
Ireland		
Nitrates GAP & POM Nutrient Management	Enhance soil nutrient retention / use efficiency	Enhance soil nutrient retention / use efficiency
Cross Compliance SMR & GAEC	Avoid soil erosion	Avoid soil erosion
Climate Action Plan	Avoiding N2O, CH4 emissions from soil	Avoiding N2O, CH4 emissions from soil
Biodiversity Action Plan 2017-2021	Enhance soil biodiversity	Enhance soil biodiversity
Environmental Impact Assessment Act	Enhance water storage capacity/ quality	Enhance water storage capacity/ quality
Direct Payments (EFA, Greening, Crop Diversification)	Maintain / Increase SOC	Maintain / Increase SOC
Latvia		
Rural Development Plan 2014 - 2020	Maintain / Increase SOC	Maintain / Increase SOC
Environmental Policy Guidelines 2014-2020	Avoid contamination	Avoid contamination
Climate Plan	Avoiding N2O, CH4 emissions from soil	Avoiding N2O, CH4 emissions from soil
Climate Neutrality	Avoiding N2O, CH4 emissions from soil	Avoiding N2O, CH4 emissions from soil
United Kingdom		
Agriculture Bill 2019-2021	Enhance soil nutrient retention / use efficiency Maintain/Increase SOC	Maintain/Increase SOC
Environmental Bill 2020	Enhance soil biodiversity	Enhance soil biodiversity
Sustainable Agricultural Land Management Strategy	Enhance soil nutrient retention/ use efficiency Enhance soil biodiversity	Enhance soil nutrient retention/ use efficiency
National Energy and Climate Plan	Avoiding N2O, CH4 emissions from soil	Avoiding N2O, CH4 emissions from soil
National Well-being Indicators Framework	Enhance water storage capacity/ quality	Enhance water storage capacity/ quality

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The soil targets identified by Switzerland and Germany were assigned to multiple soil challenges as seen in the table below. However to avoid doubling of data relevant soil targets were only used once. Those targets most relevant to the soil challenge under consideration were determined via consultation with contributors from the respective member states, and were used to create the graphs for these member states.

Table 63 Soil challenges assigned to specific targets identified by member states.

Soil Challenge	Assigned Soil Targets	Targets Used in Graph
Germany		
Enhance soil biodiversity	Regional biodiversity targets set	Regional biodiversity targets set Biodiversity index increased to 100
	Biodiversity index increased to 100	
	End use of glyphosate	
	Increase organic farming	
	Preserved typical humus content	
Avoid Contamination	End use of glyphosate	End use of glyphosate
	Amount of organic fertilizer limited	
Avoid N2O, CH4 emissions from soil	No debit in LULUCF-sector	No debit in LULUCF-sector GHG emissions reduced
	GHG emissions reduced	
	Amount of organic fertilizer limited	
	Increase organic farming	
Avoid soil erosion	Establish erosion register/monitor erosion	Establish erosion register/monitor erosion
Enhance soil nutrient retention/ use efficiency	Ex-ante determination of nutrients in soil and fertilizers	Ex-ante determination of nutrients in soil and fertilizers Amount of organic fertilizer limited
	Amount of organic fertilizer limited	
	Eutrophication decreased by 35%	
Avoid soil sealing	Reduce sealing to < 30 ha/ day	Reduce sealing to <30 ha/ day
Maintain/ Increase SOC	Preserved typical humus content	Preserved typical humus content Voluntary certification of humus farming Increase organic farming
	Voluntary certification of humus farming	
	Increase organic farming	

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Enhance water storage capacity/ quality	Eutrophication decreased by 35% Preserved typical humus content	Eutrophication decreased by 35%
Avoid peat degradation	Achieve concepts to regenerate wetlands and stabilise hydrological conditions in peats and bogs	Achieve concepts to regenerate wetlands and stabilise hydrological conditions in peats and bogs
Switzerland		
Enhance soil biodiversity	No permanent loss of soil biodiversity and activity due to agricultural soil use	No permanent loss of soil biodiversity and activity due to agricultural soil use
Avoid soil compaction	Avoiding permanent compaction of agricultural soils Avoidance of permanent compaction in agricultural soils	Avoiding permanent compaction of agricultural soils Avoidance of permanent compaction in agricultural soils
Avoid soil contamination	No permanent impairment of soil functions, water and natural habitats by pollutants from agriculture. Substantial reduction of risks to humans, animals, plants and water bodies by pesticides, fertilizers and other agricultural inputs. No impairment of soil fertility and [human] health due to inorganic or organic contaminants from agriculture Input of individual contaminants from agriculture in soils is smaller than their output and degradation	No impairment of soil fertility and [human] health due to inorganic or organic contaminants from agriculture Input of individual contaminants from agriculture in soils is smaller than their output and degradation
Enhance soil nutrient retention/ use efficiency	No permanent impairment of soil functions, water and natural habitats by pollutants from agriculture. Substantial reduction of risks to humans, animals, plants and water bodies by pesticides, fertilizers and other agricultural inputs.	No permanent impairment of soil functions, water and natural habitats by pollutants from agriculture. Substantial reduction of risks to humans, animals, plants and water bodies by pesticides, fertilizers and other agricultural inputs.
Avoid soil erosion	No permanent impairment of soil functions through erosion on agricultural land Erosion on agricultural soils has to stay below threshold	No permanent impairment of soil functions through erosion on agricultural land

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	and prevention of talweg erosion	Erosion on agricultural soils has to stay below threshold and prevention of talweg erosion No impairment of soil fertility through erosion No impairment of water bodies and semi-natural habitats by washed-away soil material from agricultural areas
	No impairment of soil fertility through erosion	
	No impairment of water bodies and semi-natural habitats by washed-away soil material from agricultural areas	
Maintain/ Increase SOC	Compensation of soil organic matter losses due to agricultural use of mineral soils.	Compensation of soil organic matter losses due to agricultural use of mineral soils.
Avoid peat degradation	Minimizing the loss of soil organic matter due to agricultural use of organic soils.	Minimizing the loss of soil organic matter due to agricultural use of organic soils.

Some soil targets were not used to create the graph, as they were not relevant to the soil challenges or no data was available for their inclusion. These targets are still considered important by the respective member state and are listed in below.

Table 64 Soil targets identified by Germany but not included in the creation of the graph for Germany in Section 3.1.3

Identified Policy	Soil Targets not included in the Graph
Germany	
German Sustainable Development Strategy	Involvement of social actors
German Federal Soil Protection Law German Strategy for Adaptation to Climate Change	Code of good practices applied
German Strategy for Adaptation to Climate Change	Networks to record soil, water and air quality
	Dialogue and knowledge transfer with experts
Climate Protection Programme	Development of grassland strategy
German Sustainable Development Strategy Discussion paper crop production strategy	Establish soil protection indicator
German Strategy for Adaptation to Climate Change	Climate impact monitoring (No data)
	Investment in sustainable agriculture, including research and advice (No data)
Climate Protection Programme German Sustainable Development Strategy	Reduction of \nitrogen surplus to 70 kg/ha (No data)

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Discussion paper crop production strategy	Development or updating of decision support tools, including digital technology (No data)
	Steady state of humus on all arable soils by 2030 (No data)
German Sustainable Development Strategy Discussion paper crop production strategy	50 mg/l nitrate in groundwater not exceeded (No data)

6.2 Assumptions and methods used in section 4.2

Horizon Scanning Responses - Qualitative responses were assigned a numerical value and a corresponding icon was assigned to specific ranges of values to convey agreement/disagreement.

Table 65 Values and icons assigned to the qualitative responses received in the survey instruments.

Qualitative Response	Assigned Numerical Value	Icon
Agree/ Yes	0 -1.4	✓
Partly agree	1.5 – 2.4	–
Disagree/ No	2.5 - 3.0	✗

In cases where individual responses from stakeholders were received instead of a summary response (Austria, Germany, and Latvia), each individual response was assigned a numerical value based on the scale above and the average over the number of respondents was used in the summary table.

Table 66 Example of calculating average summary response across multiple individual stakeholder responses.

Respondent	Answer	Assigned Score
Stakeholder 1	No	3
Stakeholder 2	Partly	2
Stakeholder 3	No	3
Stakeholder 4	Yes	1
Stakeholder 5	Partly	2
Average	**Partly**	**2.2**

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Nitrates Directive. Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (91/676/EEC).

SP-CP - Sectoral Plan for Prime Cropland Protection (A8/4/1992) - Sachplan Fruchtfolgeflächen (SP FFF) The SP-CP is an active policy that aims to maintain Swiss food security in times of disturbed or disrupted international supply chains. The SP-CP obliges the federation and the cantons to sustain the quantity and quality of 438’460 ha of prime cropland.

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