



Technical and socio-economic options to reach the Mission R&I priorities

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1 Introduction

Task 4.2 analyses the technical and socio-economic options for achieving the Soil Mission specific objectives. Based on expert consultations, this analysis considers aspects related to social and economic factors, governance, institutional arrangements, markets, environmental and ecological factors, and legal aspects that may prevent the effective implementation of research and innovation solutions. The first results of this task are presented in this deliverable.

Within the framework of the SOLO project, the Think Tanks will identify specific Knowledge Gaps, Actions and Bottlenecks to build roadmaps with actionable research and innovation strategies for the concretisation of the EU Mission “A Soil Deal for Europe”. Key concepts presented in the deliverable D4.6 for the implementation of the Regional Nodes have been agreed upon either by the partners involved in the task or by SOLO’s entire consortium:

- **Roadmaps:** actionable research and innovation strategies for the concretisation of the EU Mission “A Soil Deal for Europe”. They focus on identifying, prioritising and connecting Knowledge Gaps, Bottlenecks and Actions.
- **Knowledge Gaps:**
 - Knowledge Development Gap: a knowledge gap that requires generating new information or understanding by research or innovation, including both natural and social sciences and humanities’ contributions.
 - Knowledge Application Gap: a knowledge gap that requires research or innovation to find and test new mechanisms that allow the effective implementation of already existing information or understanding. This knowledge gap hence concentrates on the deficient links between available knowledge and its application.
 - Note: these two concepts, Knowledge Development Gap and Knowledge Application Gap, are central to the whole project and therefore key concepts in the whole SOLO development and outcomes.
- **Actions:** Actions encompass a spectrum of technical and socio-economic strategies, approaches, measures, and solutions aimed at addressing identified knowledge gaps. These actions are aligned with the R&I priorities outlined in the Mission framework. They serve as the means to achieve the research and innovation goals set forth by the Commission. While the primary focus lies on R&I, it’s essential to distinguish between research and innovation actions.
- **Bottlenecks:** Bottlenecks are barriers that prevent successful implementation of suggested actions to solve both types of knowledge gaps.

The identification of Actions by the Think Tanks is crucial for the development of targeted measures tailored to the unique challenges and circumstances in different regions. By combining the insights on technical and socio-economic options from the literature research with the insights from the Think Tanks, an informed approach to improving soil health across Europe can be established.

It is essential to look at other EU projects as these often provide valuable data and experience that can contribute to the further development of one’s own strategies and measures. Sharing knowledge and insights from various initiatives not only enhances the effectiveness of actions, but also helps to create a common understanding of the challenges related to soil health across the EU.

This report presents the findings of the literature review, in particular proposals for technical and socio-economic options derived from other projects related to soil health. These options provide

important input for the continued work of Think Tanks, as they can draw inspiration from the analysis results and gain valuable insights for identifying Think Tanks specific actions. This report also includes an assessment of their relevance to the Think Tanks, informed by both internal and external experts from the respective Think Tanks and the SOLO consortium.

2 Identification of R&I options in the field of soil health in the SOLO project

The SOLO project focuses on identifying research and innovation (R&I) options to advance soil health, drawing on a range of technical and socio-economic strategies. Within the framework of SOLO, several approaches have been employed to gather and refine these options:

- Starting with a survey conducted by Fraunhofer in September 2023 with the participation of Think Tanks that contributed initial ideas for potential soil health actions to address knowledge gaps. The survey was conducted as part of the knowledge gap identification survey in preparation for the general meeting on 5-7th of December 2023 in Barcelona.
- Additionally, scoping documents provided by these think tanks offered more specific proposals.
- Insights were further enriched by discussions and findings from the "Soil Weeks" and Regional Nodes events held in 2023 and 2024.

Beyond the SOLO project, a comprehensive literature analysis adds further depth to this initiative, enabling the extraction of insights from existing research and project reports. This analysis involves both automated searches, which allow rapid processing of vast datasets, and manual qualitative reviews, which offer detailed and context-sensitive interpretation. By integrating internal project findings with a broader literature base, SOLO aims to build a robust, evidence-informed set of options for improving soil health across diverse contexts.

2.1 Methodological approach

In research, automated literature search and analysis and manual – qualitative – literature review are two distinct yet complementary approaches to gathering and synthesising knowledge from existing sources. These two approaches are used to identify technical and socio-economic options in Task 4.2.

Automated literature search and analysis (ongoing)

Automated literature search relies on technology—specifically algorithms, artificial intelligence, and natural language processing (NLP)—to sift through vast databases of academic papers, books, and articles quickly and systematically. Automated tools can scan hundreds of thousands of documents, identifying relevant works and even summarising key themes or patterns within them. This approach saves significant time and allows researchers to rapidly cover a broader scope of literature. Automated techniques, such as text mining and machine learning, can help to detect trends, identify clusters of related work, and find less obvious connections within a field. However, this automated process often lacks the depth and context that human interpretation brings.

Manual literature review and online sources (completed)

In contrast, manual literature reviews involve a researcher personally reading and interpreting sources, allowing for a more nuanced understanding of each source's arguments, strengths, weaknesses, and context. This process is slower and more labour-intensive but offers a depth of analysis that automated methods cannot replicate. Manual review allows for critical evaluation of

sources, by considering subtle differences in arguments and assessing the quality and credibility of sources. This qualitative approach ensures a richer interpretation of content, especially for complex or interdisciplinary topics where context is crucial.

The importance of combining both approaches in the SOLO project

The combination of automated and manual approaches leverages the strengths of each while compensating for their limitations. Automated searches can efficiently handle the vast amount of information available in the digital age, filtering out irrelevant sources and highlighting potential areas of interest. Subsequent manual review allows researchers to interpret and refine these findings, adding human insight that technology currently cannot fully replicate. For example, automated methods may identify patterns, but a manual review can assess the reliability and relevance of each finding, improving the overall rigour and accuracy of the literature review.

In sum, the use of both automated and manual literature review methods allows researchers to balance efficiency with depth, covering extensive ground while maintaining the nuanced understanding necessary for high-quality research.

2.2 Current status of the automated literature search

The primary goal of the automated literature search was to pinpoint various strategies, approaches, measures, and solutions that addressed the identified knowledge gaps and bottlenecks according to SOLO aims. This effort aimed to support the research and innovation goals of the mission, ultimately leading to the creation of relevant project definitions and a comprehensive roadmap.

Our semi-automated approach to literature scanning (Geurts et al.¹, 2022; Vignoli et al., 2022²) involved applying machine learning based text-mining algorithms (e.g. KeyBERT, TextRank) to identify relevant concepts for the Think Tank's area of expertise. This methodology can briefly be summarised in the following steps:

1. Manually selecting core texts from Think Tanks' scoping documents to extract relevant keywords with natural language processing techniques that rely on unsupervised learning. This entails scrutinising the scoping documents and reports from multiple Think Tanks to pinpoint keywords that align with the project's targets.
2. Applying KeyBERT, an unsupervised machine learning algorithm commonly used in natural language processing, and embedding models (three in total), as well as the Yake! keyword extraction model to relevant texts derived from nine Think Tanks (TT) to find essential keywords to provide diverse and comprehensive results. The automated extraction yielded 20 keyword phrases with n-gram lengths between two and three words per model, i.e. 80 per TT text to be later given expert review.

Leveraging the identified keywords in conjunction with terms such as 'option', 'action', 'measure', or 'solution', to access beneficial textual content from Dimensions AI to create efficient queries to

¹ New perspectives for data-supported foresight: The hybrid AI-expert approach - Geurts - 2022 - FUTURES & FORESIGHT SCIENCE - Wiley Online Library (Geurts, A., Gutknecht, R., Warnke, P., Goetheer, A., Schirrmeister, E., Bakker, B., & Meissner, S. (2022). New perspectives for data-supported foresight: The hybrid AI-expert approach. *Futures & Foresight Science*, 4, e99. <https://doi.org/10.1002/ffo2.99>),

² Frontiers | An Exploration of the Potential of Machine Learning Tools for Media Analysis to Support Sense-Making Processes in Foresight (Vignoli M, Rörden J, Wasserbacher D and Kimpeler S (2022) An Exploration of the Potential of Machine Learning Tools for Media Analysis to Support Sense-Making Processes in Foresight. *Front. Commun.* 7:750614. doi: 10.3389/fcomm.2022.750614).

enhance the search process, incorporating keywords in a specified format, and targeting a timeframe of 2000-2024 to search for relevant publications about soil health using Dimensions AI through API access. The following example represents a query with chained combinations that group multiple keywords to nine publications between the years 2000 and 2024: (research OR innovation) AND (solution OR action OR measure OR option OR strategy OR roadmap OR result) AND (TT keyword/keywords with OR or AND operators). An Excel file will be compiled containing over 5000 relevant publications from Dimensions, which included essential metadata, such as ID, concepts scores, year, journal title, abstract, concepts, title, DOI, category, times cited, and Dimensions URL.

The final phase will involve a qualitative analysis of the top publications from the list (30-35 per Think Tank) to refine existing queries and determine if any reiteration of the previous steps will be necessary.

The process involves expert participation where experts review and assess the lists of keywords generated from the automated extraction process. These keywords are then colour-coded based on their utility for further project activities. Concurrently, the horizon scanning team undertakes tests to determine the most accurate model for ongoing keyword extraction from specified web sources.

Expert analysis of this final list is integral to refining the existing queries. This may necessitate iterations of the search and analysis process to enhance the accuracy and relevance of the queried data.

Through this structured and iterative approach, the project will ensure a thorough exploration and utilization of available information, thereby supporting the overarching research and innovation goals while enabling continuous improvement through expert feedback and advanced search methodologies.

2.3 Results from the manual literature review and online sources

The manual literature review and analysis of online sources have provided a comprehensive overview of best practices, current challenges, and innovative approaches to soil health. By manually reviewing project reports and additional literature, the research has gathered valuable insights that contribute to a more in-depth understanding of the field.

The analysis process began with a selection of nearly 50 literature sources, which produced an initial long list of nearly 290 options. This list was refined through a preliminary assessment to ensure each option qualified as either a research or innovation option. During this refinement, duplicate entries were removed, and several options were consolidated to reduce overlap. This process resulted in a refined selection of 157 options offering valuable insights as inspiration for identifying think-tank-specific actions which will be linked to the knowledge gaps in the ongoing process (Table 1). presents all the selected options with a preliminary assessment of their affiliation to the social, technological, and economic categories.

The complete list of all sources used can be found in the References chapter. A full listing of options, including a brief description and source attribution, is provided in the Appendix.

Table 1: Selected options as input for identification of specific Think Tank Actions

No	Selected Options	social	technical	economic
1	Enhance Stakeholder Awareness and Explore Alternatives	X	X	
2	Identify and Engage Key Stakeholders	X		
3	Improve Educational Programs for Stakeholders	X		
4	Collaborate with Stakeholders and Member States to Promote Education	X	X	
5	Implement Good Practices and Hands-on Education	X		
6	Develop Comprehensive Communication Strategies		X	
7	Emphasise Stakeholder Involvement	X		
8	Encourage Cross-Domain Collaboration	X		
9	Raise Awareness of Soil Literacy Among Stakeholders	X		
10	Define New Roles for Advisors		X	
11	Enhance Collaboration with Ongoing Initiatives		X	
12	Establish a Transparent and Adaptive Monitoring System		X	
13	Continuous Assessment and Adaptation			X
14	Expand Knowledge of Erosion			X
15	Explore Methods to Mitigate Erosion Risk		X	
16	Incorporate Socio-Economic Impacts of Erosion into Budgeting	X		X
17	Develop Restoration Options for Varying Conditions		X	X
18	Promote Local Erosion Control Planning		X	
19	Present Comprehensive Erosion Processes Affordably		X	X
20	Integrate and Provide Soil Management Strategy Maps		X	X
21	Assess Unsuitable Soils			X
22	Enhance Soil Water Retention Capacity		X	X
23	Promote Rainwater Retention		X	X
24	Implement Gully Control Structures		X	

No	Selected Options	social	technical	economic
25	Promote Water Harvesting		X	X
26	Encourage Water Reuse		X	X
27	Boost Soil Water Holding Capacity		X	
28	Conduct Plot-Scale Soil Observations		X	
29	Address Soil Compaction from Unsuitable Agricultural Practices		X	
30	Promote Harmonisation and Standardisation		X	X
31	Implement Targeted Erosion Mitigation Measures		X	
32	Improve Sediment Connectivity Modeling		X	
33	Develop Learning Networks for Stakeholders	X	X	
34	Assess Government Policy Impact on New Farm System Diffusion	X		X
35	Establish Science-to-Science Networks		X	X
36	Explore Regionally-Based Co-Innovation and Management Strategies	X		X
37	Develop Guidelines from Long-Term Field Experiments for Regional Knowledge Sharing	X	X	
38	Advocate Regional Knowledge Adoption Strategies	X	X	
39	Facilitate Science-Policy Dialogues	X	X	X
40	Promote Small-Scale Sustainable Agricultural Initiatives			X
41	Encourage Youth Participation	X		
42	Empower Farmers' Self-Determination	X		X
43	Enhance Communication and Implementation Potential	X	X	
44	Implement Smart Grazing Practices	X		
45	Build a Consistent Understanding of Soil Management	x		
46	Assess Driving Factors in Short, Medium, and Long Terms	X		
47	Define Prevention and Restoration Options for Each Region			X
48	Implement Cost-Effective Long-Term Monitoring of Measures			X
49	Integrate Prevention and Restoration into Common Policies	X		

No	Selected Options	social	technical	economic
50	Develop Topic-Specific Funding Schemes			X
51	Assess Public Support for Soil Organic Carbon	X		X
52	Evaluate Current and Future Policy Instruments			X
53	Analyse Land Take from a Judicial Perspective	X		X
54	Create Local Policy Frameworks	X		
55	Ensure Appropriate Land Use in Suitable Locations			X
56	Promote Land Use Specification in Legislation			X
57	Consider Incentives for Ecosystem Services	X		X
58	Highlight Benefits of a Diversified Product Portfolio	X		X
59	Enhance Regulatory Flexibility			X
60	Provide Guidance for Sustainable Soil Management	X	X	
61	Define Intermediate Steps and Realistic Objectives			X
62	Evaluate Tailored Education for Diverse Stakeholder Groups	X		X
63	Engage Soil Ambassadors	X		
64	Create Frameworks for Prevention and Compensation			X
65	Simplify Material Reuse		x	x
66	Promote Education on Soil Pollution	X		
67	Enhance Knowledge Exchange Among Stakeholders	X		X
68	Develop Holistic Guidance for Soil Lifecycle Management	X	X	
69	Share Successful Experiences	X		X
70	Disseminate Innovative Practices and Technologies to Land Managers	X	X	X
71	Improve Understanding of Soil Degradation Impacts	X		X
72	Investigate General Knowledge about Soil Services	X		
73	Establish Criteria for Urban Soil Health	X		
74	Enhance Dissemination of New Knowledge Through Existing Channels		X	

No	Selected Options	social	technical	economic
75	Assess Current Soil Education in Schools	X		
76	Promote Soil Literacy in Higher Education	X		
77	Engage Key Stakeholders and Citizens	X		
78	Build Capacity for Emerging Soil Scientists			X
79	Compile and Distribute Best Practices	X		X
80	Centralise Information from EU Soil Mission Initiatives and Citizen Engagement	X		
81	Facilitate Knowledge Transfer and Co-Creation in Living Labs and Lighthouses	X	X	
82	Address Data Gaps in Soil Health Improvement Measures		X	
83	Explore Urban Living Lab Opportunities	X	X	
84	Foster Cross-Topic Connections	X		
85	Promote Healthy Soil Awareness in Tourism	X		
86	Engage Stakeholders in Soil Policy and Management Development	X		X
87	Enhance Soil Biodiversity Indicators		X	
88	Develop Indicators for Ecosystem Services and Soil Functions		X	
89	Reevaluate the 'One Out - All Out' Principle		X	
90	Establish a Framework for Holistic Data Management		X	X
91	Address Nutrient Management Related to Soil Organic Carbon		X	
92	Develop Indicators for Land Take and Soil Sealing Dynamics		X	
93	Create Methods and Tools for Soil Lifecycle Assessment		X	
94	Explore the Potential of Digital Methods		X	
95	Promote Harmonization via Methods Exchange		X	
96	Establish Long-Term Experimental Sites for Diverse Soil Conditions		X	
97	Implement Holistic Indicators for Soil Type Interpretation		X	
98	Develop Measurement Protocols for Various Use Cases		X	X

No	Selected Options	social	technical	economic
99	Strive to Reduce Measurement Costs			X
100	Launch Open Monitoring Programs		X	X
101	Define an EU Soil Footprint		X	X
102	Create a Common Global Soil Footprint		X	
103	Explore Foresight Scenarios for Future Consumption		X	
104	Assess Policy Impacts on Soil Footprints		X	X
105	Investigate New Policy Instrument Opportunities			X
106	Identify Stakeholders Influencing Soil Health			X
107	Align with the EU Biodiversity Strategy to Set Concrete Objectives			X
108	Review Data Related to Sustainable Environments			X
109	Evaluate Current Soil Data Sharing		X	X
110	Develop a Distributed Soil Information System		X	
111	Conduct Comparative Analysis and Harmonise Soil Data Standards		X	
112	Gather Indicators on Soil Properties		X	
113	Establish a Modeling Framework for Soil Mapping		X	
114	Develop Detailed Soil Geodatabase and Mapping Resources		X	
115	Implement Remote Sensing for Soil Monitoring and Mapping		X	
116	Create Tools and Models for Strategic Integrated Policy Support		X	
117	Assess Monitoring and Soil Health Indicators for Gaps and Training Needs		X	
118	Avoid Sole Dependence on Laboratory Results for Soil Observations		X	
119	Establish 'Soil Health' Concept for Ecosystem Assessment		X	
120	Create a Tiered Approach for Harmonising Pan-European Soil Monitoring Indicators		X	
121	Expand Monitoring Beyond Heavy Metals for Comprehensive Risk Management		X	
122	Harmonise Risk Assessment Approaches for Defining 'Acceptable Levels'		X	X

No	Selected Options	social	technical	economic
123	Enhance Accounting for Diffuse and Chronic Contamination Sources			X
124	Identify Socio-Economic Drivers	X		X
125	Identify Vulnerable Areas in the EU and Assess Influences	X		X
126	Develop Unified Methods and Indicators for Soil Organic Carbon Monitoring		X	
127	Identify Optimal Conditions for Soil Organic Carbon Sequestration and Storage		X	
128	Assess Regional Potential for Soil Organic Carbon Storage			X
129	Develop Business Models for Carbon Trading			X
130	Create Databases on Land Take and Its Impacts		X	X
131	Implement Measures to Address Guidance Gaps		X	X
132	Promote Circular Economy Practices in Soil Reuse		X	X
133	Enhance Governance Effectiveness and Transparency	X		
134	Integrate Soil Functions and Services into Planning Activities		X	X
135	Focus on Long-Term Monitoring of CoC Effects and Risks		X	X
136	Enhance Regulatory Safety Assessments for Pesticides		X	
137	Evaluate Risks and Opportunities in Material Reuse		X	X
138	Utilise Machine Learning for Predictive Analysis		X	
139	Focus on Contamination Prevention and Restoration	X		X
140	Prioritise Contaminated Site Management	X	X	X
141	Integrate Socio-Economic and Biophysical Research	X		
142	Support Innovations Within Living Labs		X	
143	Address Irreversibility in Soil Management		X	
144	Develop Risk Analysis and Management Tools for Policy Guidance			X
145	Conduct Resilience Studies of Soil-Plant Systems	X		
146	Foster Interdisciplinary Connections	X		
147	Promote Knowledge Transfer from Warmer Climate Regions	X		

No	Selected Options	social	technical	economic
148	Develop a Comprehensive Understanding of Soil Properties	X	X	
149	Utilise Scenario Techniques to Foster Circular Bio-Economy			X
150	Collaborate with Horizon Europe Mission on Soil Health and Food Systems	X		
151	Assess Current Co-Innovation Process Effectiveness	X	X	
152	Implement a Short Value Chain Approach			X
153	Strengthen Urban-Rural Linkages	X		X
154	Explore Diverse Sustainable Land Management Strategies			X
155	Assess the Potential of Organic Residues from Biogas Facilities		X	
156	Collaborate with Farmers and Communities for Streamlined Approaches	X		
157	Promote the Advantages of Year-Round Soil Cover			X

2.4 Validation of results by internal and external SOLO experts

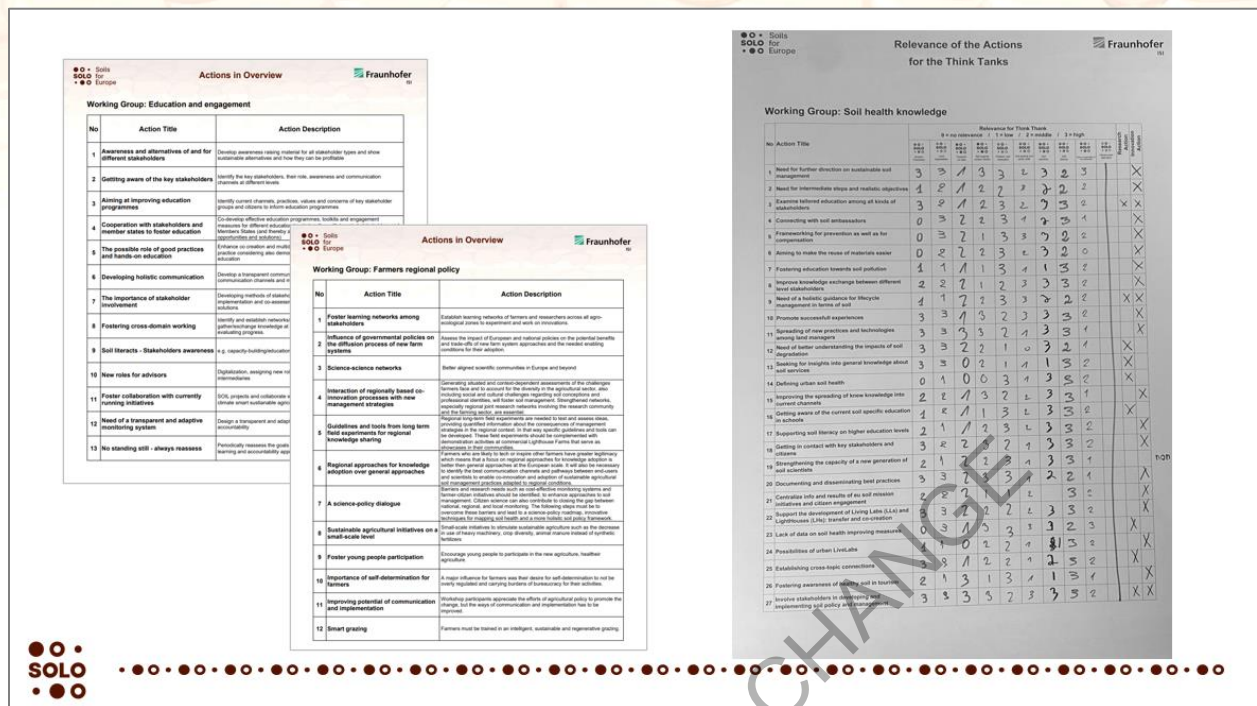
The aim of the face-to-face workshop in Sofia on November 6, 2024 was to validate the results together with the internal and external project stakeholders present on site and to gain new insights and identify overarching actions through interdisciplinary discussions. In addition, the expert discussions should also identify similarities and overarching actions between two or more think tanks where possible.

In order to make the validation of the almost 160 actions deriving from the research more feasible – especially considering the limited amount of 60 minutes for the conduction of the workshop – all participants present were divided into five groups. To ensure that knowledge from each Think Tank would be represented in each group the participants were kindly asked to distribute evenly where possible.

On each group table, the participants found a large poster with the identified R&I actions that were to be discussed and evaluated in the respective group. An example of the poster is shown below (Figure 1). In addition, all participants received a handout with a detailed description of each researched R&I action, which could serve as a guide and basis for discussion for the rest of the workshop.

The experts were also informed that both the title and description of the action could be modified for the respective Think Tank and that a narrower or broader focus could be applied to future measures. The descriptions merely served as a starting point for more in-depth discussions or as a source of ideas for think tank-specific interpretations of the particular action.

Figure 1: Examples of the workshop material.



Each group was then given the task of going through the list of identified actions and discussing the relevance of the action dimension for each Think Tank. For this purpose, a measurement scale of zero to three was used, with 0 representing no relevance of the topic, 1 indicating a low relevance for the particular Think Tank, 2 a moderate relevance and 3 a high relevance for the Think Tank concerned.

In addition to assessing the relevance of the topic, in a second step, the participants were also asked to identify whether the mentioned action would be considered a research or innovation action. As a final task, the groups should, if possible, mark actions with a Think Tank cross-cutting nature.

At the end of the small group workshop phase, the participants were invited to share their findings and experiences from the action refinement process with the plenary. On the one hand, this revealed that actions and their descriptions had to be reformulated in order to meet the needs of the respective Think Tanks and fulfil the thematic focus. In addition, the brief presentation already revealed that the group discussion brought to light synergy effects and cross-fertilisation with regard to the R&I actions discussed. Please see below for a detailed evaluation of the workshop results.

Comments on the workshop process: Due to interpretative difficulties in clearly distinguishing between research and innovation actions, some of the actions processed remained unorganised. Within the framework of further workshops, the relevant actions will be clearly assigned to either category research or innovation in the future, as a clear assignment cannot be made without the participation of the respective Think Tanks. As the persisting definitions need further refinement for a better usability.

3 First ideas on technical and socio-economic options

The initial identification of technical and socio-economic options in the SOLO project focuses on Think-Tank-specific insights, aiming to highlight the most relevant strategies for each Think Tank involved. This section presents a selection of 15 options for each individual Think Tank, based on their high relevance to the respective Think Tank's focus.

- Options that also demonstrate medium or high relevance across multiple Think Tanks are emphasised in bold to account for their overarching character across the different Think Tanks for broader applicability.
- The selected fifteen options were put into the list in random order. The numbering does not imply a hierarchy of importance.
- To ensure traceability, each option is accompanied by its original reference number and a designation as either a Research (R) or Innovation (I) option.

Additionally, a summary table (Table 2) in the “General Findings” section lists the 13 options identified as most relevant across all Think Tanks, offering a consolidated view of the top strategies for soil health advancement.

3.1 Think Tank specific findings

3.1.1 Prevent erosion

1. **Develop a Comprehensive Understanding of Soil Properties 148 (R)**
2. **Explore Diverse Sustainable Land Management Strategies 154 (R)**
3. **Engage Stakeholders in Soil Policy and Management Development 86 (R) (I)**
4. Develop Indicators for Ecosystem Services and Soil Functions 88 (R)
5. **Develop a Distributed Soil Information System 110 (I)**
6. **Promote the Advantages of Year-Round Soil Cover 157 (R) (I)**
7. Establish Long-Term Experimental Sites for Diverse Soil Conditions 96 (R)
8. **Develop Risk Analysis and Management Tools for Policy Guidance 144 (I)**
9. **Encourage Cross-Domain Collaboration 8 (R) (I)**
10. Expand Knowledge of Erosion 14 (R)
11. Develop Guidelines from Long-Term Field Experiments for Regional Knowledge Sharing 37 (R) (I)
12. Provide Guidance for Sustainable Soil Management 60 (I)
13. Share Successful Experiences 69 (I)
14. Identify Stakeholders Influencing Soil Health 106 (R)
15. Create Tools and Models for Strategic Integrated Policy Support 116

3.1.2 Reduce land degradation

1. **Develop a Comprehensive Understanding of Soil Properties 148 (R)**
2. **Explore Diverse Sustainable Land Management Strategies 154 (R)**
3. **Engage Stakeholders in Soil Policy and Management Development 86 (R) (I)**
4. Develop Indicators for Ecosystem Services and Soil Functions 88 (R)
5. **Develop a Distributed Soil Information System 110 (I)**
6. Establish Long-Term Experimental Sites for Diverse Soil Conditions 96 (R)
7. **Develop Risk Analysis and Management Tools for Policy Guidance 144 (I)**
8. **Encourage Cross-Domain Collaboration 8 (R) (I)**
9. Expand Knowledge of Erosion 14 (R)

10. Develop Guidelines from Long-Term Field Experiments for Regional Knowledge Sharing 37 (R) (I)
11. Provide Guidance for Sustainable Soil Management 60 (I)
12. Share Successful Experiences 69 (I)
13. Establish a Framework for Holistic Data Management 90 (I)
- 14. Implement Holistic Indicators for Soil Type Interpretation 97 (I)**
15. Identify Stakeholders Influencing Soil Health 106 (R)

3.1.3 Reduce the EU global footprint on soils

- 1. Develop a Comprehensive Understanding of Soil Properties 148 (R)**
- 2. Explore Diverse Sustainable Land Management Strategies 154 (R)**
- 3. Engage Stakeholders in Soil Policy and Management Development 86 (R) (I)**
4. Develop Indicators for Ecosystem Services and Soil Functions 88 (R)
- 5. Develop a Distributed Soil Information System 110 (I)**
- 6. Promote the Advantages of Year-Round Soil Cover 157 (R) (I)**
7. Establish Long-Term Experimental Sites for Diverse Soil Conditions 96 (R)
8. Identify Socio-Economic Drivers 124 (I)
9. Implement Measures to Address Guidance Gaps 131 (I)
10. Expand Knowledge of Erosion 14 (R)
11. Develop Guidelines from Long-Term Field Experiments for Regional Knowledge Sharing 37 (R) (I)
12. Establish a Framework for Holistic Data Management 90 (I)
- 13. Implement Holistic Indicators for Soil Type Interpretation 97 (I)**
14. Identify Stakeholders Influencing Soil Health 106 (R)
15. Create Tools and Models for Strategic Integrated Policy Support 116

3.1.4 Conserve and increase soil organic carbon stocks

- 1. Develop a Comprehensive Understanding of Soil Properties 148 (R)**
- 2. Explore Diverse Sustainable Land Management Strategies 154 (R)**
- 3. Engage Stakeholders in Soil Policy and Management Development 86 (R) (I)**
- 4. Promote the Advantages of Year-Round Soil Cover 157 (R) (I)**
5. Establish Long-Term Experimental Sites for Diverse Soil Conditions 96 (R)
6. Identify Socio-Economic Drivers 124 (I)
- 7. Implement Measures to Address Guidance Gaps 131 (I)**
- 8. Encourage Cross-Domain Collaboration 8 (R) (I)**
9. Expand Knowledge of Erosion 14 (R)
10. Develop Guidelines from Long-Term Field Experiments for Regional Knowledge Sharing 37 (R) (I)
11. Provide Guidance for Sustainable Soil Management 60 (I)
12. Share Successful Experiences 69 (I)
13. Establish a Framework for Holistic Data Management 90 (I)
14. Collaborate with Stakeholders and Member States to Promote Education 4 (I)
15. Implement Good Practices and Hands-on Education 5 (I)

3.1.5 Reduce soil pesticide pollution and enhance restoration

- 1. Develop a Comprehensive Understanding of Soil Properties 148 (R)**
- 2. Explore Diverse Sustainable Land Management Strategies 154 (R)**
3. Develop Indicators for Ecosystem Services and Soil Functions 88 (R)
- 4. Develop a Distributed Soil Information System 110 (I)**
- 5. Promote the Advantages of Year-Round Soil Cover 157 (R) (I)**

6. Establish Long-Term Experimental Sites for Diverse Soil Conditions 96 (R)
7. Identify Socio-Economic Drivers 124 (I)
8. Implement Measures to Address Guidance Gaps 131 (I)
- 9. Develop Risk Analysis and Management Tools for Policy Guidance 144 (I)**
10. Develop Guidelines from Long-Term Field Experiments for Regional Knowledge Sharing 37 (R) (I)
11. Provide Guidance for Sustainable Soil Management 60 (I)
12. Establish a Framework for Holistic Data Management 90 (I)
- 13. Implement Holistic Indicators for Soil Type Interpretation 97 (I)**
14. Identify Stakeholders Influencing Soil Health 106 (R)
15. Create Tools and Models for Strategic Integrated Policy Support 116

3.1.6 No net soil sealing and increase the reuse of urban soils

- 1. Develop a Comprehensive Understanding of Soil Properties 148 (R)**
- 2. Engage Stakeholders in Soil Policy and Management Development 86 (R) (I)**
3. Develop Indicators for Ecosystem Services and Soil Functions 88 (R)
4. Identify Socio-Economic Drivers 124 (I)
- 5. Implement Measures to Address Guidance Gaps 131 (I)**
- 6. Encourage Cross-Domain Collaboration 8 (R) (I)**
7. Share Successful Experiences 69 (I)
8. Integrate Prevention and Restoration into Common Policies 49 (R)
9. Ensure Appropriate Land Use in Suitable Locations 55 (R)
10. Enhance Soil Biodiversity Indicators 87 (I)
11. Promote Harmonization via Methods Exchange 95 (I)
12. Implement Remote Sensing for Soil Monitoring and Mapping 115
13. Integrate Soil Functions and Services into Planning Activities 134 (R) (I)
14. Create Local Policy Frameworks 54 (I)
15. Address Data Gaps in Soil Health Improvement Measures 82 (R)

3.1.7 Improve soil structure

- 1. Develop a Comprehensive Understanding of Soil Properties 148 (R)**
- 2. Engage Stakeholders in Soil Policy and Management Development 86 (R) (I)**
3. Develop Indicators for Ecosystem Services and Soil Functions 88 (R)
4. Identify Socio-Economic Drivers 124 (I)
- 5. Implement Measures to Address Guidance Gaps 131 (I)**
- 6. Encourage Cross-Domain Collaboration 8 (R) (I)**
7. Share Successful Experiences 69 (I)
8. Integrate Prevention and Restoration into Common Policies 49 (R)
9. Ensure Appropriate Land Use in Suitable Locations 55 (R)
10. Enhance Soil Biodiversity Indicators 87 (I)
11. Promote Harmonization via Methods Exchange 95 (I)
12. Implement Remote Sensing for Soil Monitoring and Mapping 115
13. Integrate Soil Functions and Services into Planning Activities 134 (R) (I)
14. Create Local Policy Frameworks 54 (I)
15. Address Data Gaps in Soil Health Improvement Measures 82 (R)

3.1.8 Increase soil literacy in Member States

- 1. Develop a Comprehensive Understanding of Soil Properties 148 (R)**
- 2. Engage Stakeholders in Soil Policy and Management Development 86 (R) (I)**
3. Develop Indicators for Ecosystem Services and Soil Functions 88 (R)

4. **Develop a Distributed Soil Information System 110 (I)**
5. **Promote the Advantages of Year-Round Soil Cover 157 (R) (I)**
6. Establish Long-Term Experimental Sites for Diverse Soil Conditions 96 (R)
7. Identify Socio-Economic Drivers 124 (I)
8. **Implement Measures to Address Guidance Gaps 131 (I)**
9. **Develop Risk Analysis and Management Tools for Policy Guidance 144 (I)**
10. Expand Knowledge of Erosion 14 (R)
11. Share Successful Experiences 69 (I)
12. Establish a Framework for Holistic Data Management 90 (I)
13. Identify Stakeholders Influencing Soil Health 106 (R)
14. Foster Interdisciplinary Connections 146 (I)
15. Collaborate with Stakeholders and Member States to Promote Education 4 (I)

3.1.9 Nature conservation of soil biodiversity

1. **Develop a Comprehensive Understanding of Soil Properties 148 (R)**
2. **Explore Diverse Sustainable Land Management Strategies 154 (R)**
3. **Engage Stakeholders in Soil Policy and Management Development 86 (R) (I)**
4. Develop Indicators for Ecosystem Services and Soil Functions 88 (R)
5. **Develop a Distributed Soil Information System 110 (I)**
6. **Promote the Advantages of Year-Round Soil Cover 157 (R) (I)**
7. **Identify Socio-Economic Drivers 124 (I)**
8. **Implement Measures to Address Guidance Gaps 131 (I)**
9. **Develop Risk Analysis and Management Tools for Policy Guidance 144 (I)**
10. Expand Knowledge of Erosion 14 (R)
11. Share Successful Experiences 69 (I)
12. Establish a Framework for Holistic Data Management 90 (I)
13. Identify Stakeholders Influencing Soil Health 106 (R)
14. **Foster Interdisciplinary Connections 146 (I)**
15. Collaborate with Stakeholders and Member States to Promote Education 4 (I)

3.2 Preliminary findings with increased relevance for all Think Tanks

Table 2 presents all options with a medium or high relevance for all Think Tanks based on the results of the Workshop in Sofia.

Table 2: Options identified as most relevant across all Think Tanks

No	Option Title	Short Description	Research Option	Innovation Option
148	Develop a Comprehensive Understanding of Soil Properties	Increase understanding of soil functioning and resilience, along with the contributions of soils to ecosystem services across various conditions.	X	
154	Explore Diverse Sustainable Land Management Strategies	Investigate diverse strategies, including cover crops and crop rotations, to promote sustainable land management.	X	

No	Option Title	Short Description	Research Option	Innovation Option
86	Engage Stakeholders in Soil Policy and Management Development	Ensure the early involvement of stakeholders in the development of national soil monitoring programs to promote acceptance and shared interest in indicators, reference values, and target values for soil quality, incorporating practical knowledge on land management and the potential for payments for ecosystem services.	X	X
110	Develop a Distributed Soil Information System	Create an easy-to-update distributed soil information system that links sharable national data from EU members according to INSPIRE and allows querying through a portal.		X
157	Promote the Advantages of Year-Round Soil Cover	Incentivise the implementation of year-round soil cover practices through financial assistance or legislative measures.	X	X
124	Identify Socio-Economic Drivers	Identify and assess the socio-economic drivers for land degradation and related desertification processes across various scales.		X
131	Implement Measures to Address Guidance Gaps	Identify, assess, and demonstrate measures to reduce or prevent soil sealing, rehabilitate contaminated soils, and increase water infiltration through nature-based solutions.		X
144	Develop Risk Analysis and Management Tools for Policy Guidance	Apply risk analysis tools related to various environmental management issues to guide policies in response to changing climate conditions.		X
8	Encourage Cross-Domain Collaboration	Identify and establish networks and coalitions to foster collaboration and facilitate the exchange of knowledge at EU and global levels for ongoing monitoring and evaluation of progress.	X	X
97	Implement Holistic Indicators for Soil Type Interpretation	Develop and test indicators to assess soil structure and biodiversity for various soil types, establishing benchmark values linked to crop health.		X
146	Foster Interdisciplinary Connections	Connect with other fields to integrate and mainstream climate change adaptation into existing workflows.		X
81	Facilitate Knowledge Transfer and Co-Creation in Living Labs and Lighthouses	Identify and support key actions and innovations in living labs and lighthouses, including the mapping of current and emerging initiatives, co-designing		X

No	Option Title	Short Description	Research Option	Innovation Option
		business plans, and prioritising specific soil needs for knowledge transfer and co-creation.		
117	Assess Monitoring and Soil Health Indicators for Gaps and Training Needs	Evaluate the indicators proposed for monitoring soil health, focusing on consolidating the monitoring framework and defining training needs.		

4 Outlook on the next steps in Task 4.2.

The next steps for Task 4.2 are described shortly in the following section. Once the automated search has been completed, the results found will be analysed together with our data experts and, if necessary, the formulated queries will be adjusted. Once the first assessment has been completed, the results found will be cleaned up and prepared for submission to a relevance assessment by the Think Tanks concerned. This will either happen by means of a survey or as part of a workshop in an on-site meeting. In the next step, the previous results and results of the literature review results will be evaluated, clustered and summarised together with the experts.

Given the large number of R&I actions that have already been identified and are still to be expected, it will be essential to prioritise the most important actions together with the Think Tank experts in the further course of the research project in order to ensure the practicability and manageability of the merged roadmap.

The results of Task 4.2 will feed into Tasks 2.2 and 4.1, and this analysis will be regionalised in Task 4.3, as limitations and opportunities are likely to be strongly influenced by regional differences in soil type, landscape, land owner structure, management type, specific governance and institutional arrangements, perceptions of the population, links between rural and urbanised areas, and market incentives.

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7 Appendix

7.1 Options with the highest relevance for the individual Think Tanks

Legend:

Light grey options: This section presents a selection of 15 options for each individual Think Tank, based on their high relevance to the respective Think Tank's focus. Options that also demonstrate medium or high relevance across multiple Think Tanks are emphasised in bold for broader applicability. To ensure traceability, each option is accompanied by its original reference number and a designation as either a Research (R) or Innovation (I) option.

Dark grey and italicised options: Further options with the highest relevance for an individual Think Tank.

7.1.1 Prevent erosion

1. **Develop a Comprehensive Understanding of Soil Properties 148 (R)**
2. **Explore Diverse Sustainable Land Management Strategies 154 (R)**
3. **Engage Stakeholders in Soil Policy and Management Development 86 (R) (I)**
4. Develop Indicators for Ecosystem Services and Soil Functions 88 (R)
5. **Develop a Distributed Soil Information System 110 (I)**
6. **Promote the Advantages of Year-Round Soil Cover 157 (R) (I)**
7. Establish Long-Term Experimental Sites for Diverse Soil Conditions 96 (R)
8. **Develop Risk Analysis and Management Tools for Policy Guidance 144 (I)**
9. **Encourage Cross-Domain Collaboration 8 (R) (I)**
10. Expand Knowledge of Erosion 14 (R)
11. Develop Guidelines from Long-Term Field Experiments for Regional Knowledge Sharing 37 (R) (I)
12. Provide Guidance for Sustainable Soil Management 60 (I)
13. Share Successful Experiences 69 (I)
14. Identify Stakeholders Influencing Soil Health; 106 (R)
15. Create Tools and Models for Strategic Integrated Policy Support 116
16. *Foster Interdisciplinary Connections 146 (I)*
17. *Collaborate with Stakeholders and Member States to Promote Education 4 (I)*
18. *Implement Good Practices and Hands-on Education 5 (I)*
19. *Emphasise Stakeholder Involvement 7 (I)*
20. *Develop Learning Networks for Stakeholders 33 (I)*
21. *Advocate Regional Knowledge Adoption Strategies 38 (R) (I)*
22. *Implement Cost-Effective Long-Term Monitoring of Measures 48 (R) (I)*
23. *Ensure Appropriate Land Use in Suitable Locations 55 (R)*
24. *Disseminate Innovative Practices and Technologies to Land Managers 70 (I)*
25. *Facilitate Knowledge Transfer and Co-Creation in Living Labs and LightHouses 81(I)*
26. *Promote Harmonization via Methods Exchange 95 (I)*
27. *Gather Indicators on Soil Properties 112*

28. Establish a Modeling Framework for Soil Mapping 113
29. Assess Current Co-Innovation Process Effectiveness 151 (R)
30. Improve Educational Programs for Stakeholders 3 (R) (I)
31. Assess Government Policy Impact on New Farm System Diffusion 34 (R)
32. Explore Regionally-Based Co-Innovation and Management Strategies 36 (R) (I)
33. Enhance Communication and Implementation Potential 43 (I)
34. Create Local Policy Frameworks 54 (I)
35. Evaluate Tailored Education for Diverse Stakeholder Groups 62 (R) (I)
36. Engage Key Stakeholders and Citizens 77 (I)
37. Reevaluate the 'One Out - All Out' Principle 89 (I)
38. Launch Open Monitoring Programs 100
39. Develop Detailed Soil Geodatabase and Mapping Resources 114
40. Create a Tiered Approach for Harmonising Pan-European Soil Monitoring Indicators 120
41. Integrate Socio-Economic and Biophysical Research 141 (R)
42. Support Innovations Within Living Labs 142 (I)
43. Identify and Engage Key Stakeholders 2 (R)
44. Establish a Transparent and Adaptive Monitoring System 12 (I)
45. Integrate and Provide Soil Management Strategy Maps 20 (R) (I)
46. Compile and Distribute Best Practices 79 (I)
47. Develop Restoration Options for Varying Conditions 17 (I)
48. Consider Incentives for Ecosystem Services 57 (I)
49. Foster Cross-Topic Connections 84 (R)
50. Conduct Plot-Scale Soil Observations 28 (I)
51. Facilitate Science-Policy Dialogues 39 (R) (I)
52. Raise Awareness of Soil Literacy Among Stakeholders 9 (I)
53. Explore Methods to Mitigate Erosion Risk 15 (R)
54. Address Soil Compaction from Unsuitable Agricultural Practices 29 (R) (I)
55. Improve Understanding of Soil Degradation Impacts 71 (R)
56. Continuous Assessment and Adaptation 13 (R)
57. Investigate General Knowledge about Soil Services 72 (R)
58. Present Comprehensive Erosion Processes Affordably 19 (I)
59. Implement Targeted Erosion Mitigation Measures 31 (I)
60. Improve Sediment Connectivity Modeling 32 (R) (I)

7.1.2 Reduce land degradation

- 1. Develop a Comprehensive Understanding of Soil Properties 148 (R)**
- 2. Explore Diverse Sustainable Land Management Strategies 154 (R)**
- 3. Engage Stakeholders in Soil Policy and Management Development 86 (R) (I)**
4. Develop Indicators for Ecosystem Services and Soil Functions 88 (R)
- 5. Develop a Distributed Soil Information System 110 (I)**
6. Establish Long-Term Experimental Sites for Diverse Soil Conditions 96 (R)
- 7. Develop Risk Analysis and Management Tools for Policy Guidance 144 (I)**
- 8. Encourage Cross-Domain Collaboration 8 (R) (I)**
9. Expand Knowledge of Erosion 14 (R)
10. Develop Guidelines from Long-Term Field Experiments for Regional Knowledge Sharing 37 (R) (I)
11. Provide Guidance for Sustainable Soil Management 60 (I)
12. Share Successful Experiences 69 (I)
13. Establish a Framework for Holistic Data Management 90 (I)
- 14. Implement Holistic Indicators for Soil Type Interpretation 97 (I)**

15. Identify Stakeholders Influencing Soil Health 106 (R)
16. Create Tools and Models for Strategic Integrated Policy Support 116
17. Collaborate with Stakeholders and Member States to Promote Education 4 (I)
18. Implement Good Practices and Hands-on Education 5 (I)
19. Develop Learning Networks for Stakeholders 33 (I)
20. Implement Cost-Effective Long-Term Monitoring of Measures 48 (R) (I)
21. Integrate Prevention and Restoration into Common Policies 49 (R)
22. Ensure Appropriate Land Use in Suitable Locations 55 (R)
23. Disseminate Innovative Practices and Technologies to Land Managers 70 (I)
24. Facilitate Knowledge Transfer and Co-Creation in Living Labs and LightHouses 81 (I)
25. Enhance Soil Biodiversity Indicators 87 (I)
26. Promote Harmonisation via Methods Exchange 95 (I)
27. Gather Indicators on Soil Properties 112
28. Establish a Modeling Framework for Soil Mapping 113
29. Implement Remote Sensing for Soil Monitoring and Mapping 115
30. Assess Monitoring and Soil Health Indicators for Gaps and Training Needs 117
31. Establish 'Soil Health' Concept for Ecosystem Assessment 119
32. Assess Current Co-Innovation Process Effectiveness 151 (R)
33. Improve Educational Programs for Stakeholders 3 (R) (I)
34. Assess Government Policy Impact on New Farm System Diffusion 34 (R)
35. Explore Regionally-Based Co-Innovation and Management Strategies 36 (R) (I)
36. Enhance Communication and Implementation Potential 43 (I)
37. Address Data Gaps in Soil Health Improvement Measures 82 (R)
38. Reevaluate the 'One Out - All Out' Principle 89 (I)
39. Create Methods and Tools for Soil Lifecycle Assessment 93 (I)
40. Launch Open Monitoring Programs 100
41. Develop Detailed Soil Geodatabase and Mapping Resources 114
42. Create a Tiered Approach for Harmonising Pan-European Soil Monitoring Indicators 120
43. Collaborate with Farmers and Communities for Streamlined Approaches 156 (I)
44. Enhance Stakeholder Awareness and Explore Alternatives 1 (I)
45. Enhance Collaboration with Ongoing Initiatives 11 (R)
46. Establish a Transparent and Adaptive Monitoring System 12 (I)
47. Build a Consistent Understanding of Soil Management 45 (R)
48. Compile and Distribute Best Practices 79 (I)
49. Address Nutrient Management Related to Soil Organic Carbon 91 (R)
50. Develop Measurement Protocols for Various Use Cases 98 (I)
51. Develop Restoration Options for Varying Conditions 17 (I)
52. Promote Small-Scale Sustainable Agricultural Initiatives 40 (I)
53. Create Frameworks for Prevention and Compensation 64 (I)
54. Foster Cross-Topic Connections 84 (R)
55. Facilitate Science-Policy Dialogues 39 (R) (I)
56. Assess Driving Factors in Short, Medium, and Long Terms 46 (R)
57. Define Prevention and Restoration Options for Each Region 47 (I)
58. Develop Indicators for Land Take and Soil Sealing Dynamics 92 (I)
59. Create a Common Global Soil Footprint 102 (I)
60. Review Data Related to Sustainable Environments 108
61. Identify Vulnerable Areas in the EU and Assess Influences 125 (I)
62. Identify Optimal Conditions for Soil Organic Carbon Sequestration and Storage 127 (R) (I)
63. Explore Methods to Mitigate Erosion Risk 15 (R)
64. Engage Soil Ambassadors 63 (I)

- 65. *Improve Understanding of Soil Degradation Impacts* 71 (R)
- 66. *Develop Unified Methods and Indicators for Soil Organic Carbon Monitoring* 126 (R)
- 67. *Investigate General Knowledge about Soil Services* 72 (R)
- 68. *Focus on Contamination Prevention and Restoration* 139 (I)
- 69. *Enhance Accounting for Diffuse and Chronic Contamination Sources* 123 (I)
- 70. *Assess Regional Potential for Soil Organic Carbon Storage* 128 (I)
- 71. *Present Comprehensive Erosion Processes Affordably* 19 (I)
- 72. *Develop Business Models for Carbon Trading* 129 (I)
- 73. *Assess the Potential of Organic Residues from Biogas Facilities* 155 (R)
- 74. *Enhance Regulatory Flexibility* 59
- 75. *Encourage Water Reuse* 26 (R) (I)

7.1.3 Reduce the EU global footprint on soils

- 1. Develop a Comprehensive Understanding of Soil Properties** 148 (R)
- 2. Explore Diverse Sustainable Land Management Strategies** 154 (R)
- 3. Engage Stakeholders in Soil Policy and Management Development** 86 (R) (I)
- 4. *Develop Indicators for Ecosystem Services and Soil Functions* 88 (R)
- 5. Develop a Distributed Soil Information System** 110 (I)
- 6. Promote the Advantages of Year-Round Soil Cover** 157 (R) (I)
- 7. *Establish Long-Term Experimental Sites for Diverse Soil Conditions* 96 (R)
- 8. *Identify Socio-Economic Drivers* 124 (I)
- 9. *Implement Measures to Address Guidance Gaps* 131 (I)
- 10. *Expand Knowledge of Erosion* 14 (R)
- 11. *Develop Guidelines from Long-Term Field Experiments for Regional Knowledge Sharing* 37 (R) (I)
- 12. *Establish a Framework for Holistic Data Management* 90 (I)
- 13. Implement Holistic Indicators for Soil Type Interpretation** 97 (I)
- 14. *Identify Stakeholders Influencing Soil Health* 106 (R)
- 15. *Create Tools and Models for Strategic Integrated Policy Support* 116
- 16. *Foster Interdisciplinary Connections* 146 (I)
- 17. *Emphasise Stakeholder Involvement* 7 (I)
- 18. *Disseminate Innovative Practices and Technologies to Land Managers* 70 (I)
- 19. *Enhance Soil Biodiversity Indicators* 87 (I)
- 20. *Promote Harmonisation via Methods Exchange* 95 (I)
- 21. *Establish a Modeling Framework for Soil Mapping* 113
- 22. *Implement Remote Sensing for Soil Monitoring and Mapping* 115
- 23. *Establish 'Soil Health' Concept for Ecosystem Assessment* 119
- 24. *Assess Government Policy Impact on New Farm System Diffusion* 34 (R)
- 25. *Launch Open Monitoring Programs* 100
- 26. *Explore Foresight Scenarios for Future Consumption* 103 (R)
- 27. *Align with the EU Biodiversity Strategy to Set Concrete Objectives* 107 (I)
- 28. *Develop Detailed Soil Geodatabase and Mapping Resources* 114
- 29. *Create a Tiered Approach for Harmonising Pan-European Soil Monitoring Indicators* 120
- 30. *Conduct Resilience Studies of Soil-Plant Systems* 145 (R)
- 31. *Collaborate with Horizon Europe Mission on Soil Health and Food Systems* 150 (I)
- 32. *Collaborate with Farmers and Communities for Streamlined Approaches* 156 (I)
- 33. *Identify and Engage Key Stakeholders* 2 (R)
- 34. *Build a Consistent Understanding of Soil Management* 45 (R)
- 35. *Explore the Potential of Digital Methods* 94 (I)
- 36. *Strive to Reduce Measurement Costs* 99 (I)

37. *Create Databases on Land Take and Its Impacts* 130 (R)
38. *Facilitate Science-Policy Dialogues* 39 (R) (I)
39. *Develop Indicators for Land Take and Soil Sealing Dynamics* 92 (I)
40. *Create a Common Global Soil Footprint* 102 (I)
41. *Review Data Related to Sustainable Environments* 108
42. *Evaluate Current Soil Data Sharing* 109
43. *Conduct Comparative Analysis and Harmonise Soil Data Standards* 111 (I)
44. *Assess Policy Impacts on Soil Footprints* 104 (R)
45. *Develop Unified Methods and Indicators for Soil Organic Carbon Monitoring* 126 (R)
46. *Continuous Assessment and Adaptation* 13 (R)
47. *Promote Healthy Soil Awareness in Tourism* 85 (I)
48. *Define an EU Soil Footprint* 101 (R)
49. *Investigate New Policy Instrument Opportunities* 105 (I)
50. *Address Irreversibility in Soil Management* 143 (I)
51. *Enhance Accounting for Diffuse and Chronic Contamination Sources* 123 (I)
52. *Focus on Long-Term Monitoring of CoC Effects and Risks* 135 (R) (I)
53. *Expand Monitoring Beyond Heavy Metals for Comprehensive Risk Management* 121 (R) (I)

7.1.4 Conserve and increase soil organic carbon stocks

- 1. Develop a Comprehensive Understanding of Soil Properties** 148 (R)
- 2. Explore Diverse Sustainable Land Management Strategies** 154 (R)
- 3. Engage Stakeholders in Soil Policy and Management Development** 86 (R) (I)
- 4. Promote the Advantages of Year-Round Soil Cover** 157 (R) (I)
5. *Establish Long-Term Experimental Sites for Diverse Soil Conditions* 96 (R)
6. *Identify Socio-Economic Drivers* 124 (I)
- 7. Implement Measures to Address Guidance Gaps** 131 (I)
- 8. Encourage Cross-Domain Collaboration** 8 (R) (I)
9. *Expand Knowledge of Erosion* 14 (R)
10. *Develop Guidelines from Long-Term Field Experiments for Regional Knowledge Sharing* 37 (R) (I)
11. *Provide Guidance for Sustainable Soil Management* 60 (I)
12. *Share Successful Experiences* 69 (I)
13. *Establish a Framework for Holistic Data Management* 90 (I)
14. *Collaborate with Stakeholders and Member States to Promote Education* 4 (I)
15. *Implement Good Practices and Hands-on Education* 5 (I)
16. *Emphasise Stakeholder Involvement* 7 (I)
17. *Develop Learning Networks for Stakeholders* 33 (I)
18. *Advocate Regional Knowledge Adoption Strategies* 38 (R) (I)
19. *Implement Cost-Effective Long-Term Monitoring of Measures* 48 (R) (I)
20. *Ensure Appropriate Land Use in Suitable Locations* 55 (R)
21. *Disseminate Innovative Practices and Technologies to Land Managers* 70 (I)
22. *Implement Remote Sensing for Soil Monitoring and Mapping* 115
23. *Assess Monitoring and Soil Health Indicators for Gaps and Training Needs* 117
24. *Assess Government Policy Impact on New Farm System Diffusion* 34 (R)
25. *Explore Regionally-Based Co-Innovation and Management Strategies* 36 (R) (I)
26. *Enhance Communication and Implementation Potential* 43 (I)
27. *Create Local Policy Frameworks* 54 (I)
28. *Engage Key Stakeholders and Citizens* 77 (I)
29. *Address Data Gaps in Soil Health Improvement Measures* 82 (R)

30. *Reevaluate the 'One Out - All Out' Principle* 89 (I)
31. *Explore Foresight Scenarios for Future Consumption* 103 (R)
32. *Create a Tiered Approach for Harmonizing Pan-European Soil Monitoring Indicators* 120
33. *Integrate Socio-Economic and Biophysical Research* 141 (R)
34. *Support Innovations Within Living Labs* 142 (I)
35. *Conduct Resilience Studies of Soil-Plant Systems* 145 (R)
36. *Collaborate with Farmers and Communities for Streamlined Approaches* 156 (I)
37. *Identify and Engage Key Stakeholders* 2 (R)
38. *Enhance Collaboration with Ongoing Initiatives* 11 (R)
39. *Establish a Transparent and Adaptive Monitoring System* 12 (I)
40. *Integrate and Provide Soil Management Strategy Maps* 20 (R) (I)
41. *Boost Soil Water Holding Capacity* 27 (R) (I)
42. *Compile and Distribute Best Practices* 79 (I)
43. *Address Nutrient Management Related to Soil Organic Carbon* 91 (R)
44. *Develop Restoration Options for Varying Conditions* 17 (I)
45. *Enhance Soil Water Retention Capacity* 22 (R) (I)
46. *Promote Small-Scale Sustainable Agricultural Initiatives* 40 (I)
47. *Consider Incentives for Ecosystem Services* 57 (I)
48. *Enhance Dissemination of New Knowledge Through Existing Channels* 74 (I)
49. *Conduct Plot-Scale Soil Observations* 28 (I)
50. *Assess Driving Factors in Short, Medium, and Long Terms* 46 (R)
51. *Identify Optimal Conditions for Soil Organic Carbon Sequestration and Storage* 127 (R) (I)
52. *Explore Methods to Mitigate Erosion Risk* 15 (R)
53. *Assess Policy Impacts on Soil Footprints* 104 (R)
54. *Develop Unified Methods and Indicators for Soil Organic Carbon Monitoring* 126 (R)
55. *Enhance Governance Effectiveness and Transparency* 133 (I)
56. *Implement Smart Grazing Practices* 44 (I)
57. *Investigate New Policy Instrument Opportunities* 105 (I)
58. *Present Comprehensive Erosion Processes Affordably* 19 (I)
59. *Promote Rainwater Retention* 23 (R) (I)
60. *Promote Water Harvesting* 25 (R) (I)
61. *Assess Public Support for Soil Organic Carbon* 51 (R)
62. *Implement Targeted Erosion Mitigation Measures* 31 (I)
63. *Assess Unsuitable Soils* 21 (R)
64. *Implement Gully Control Structures* 24 (R) (I)

7.1.5 Reduce soil pesticide pollution and enhance restoration

- 1. Develop a Comprehensive Understanding of Soil Properties** 148 (R)
- 2. Explore Diverse Sustainable Land Management Strategies** 154 (R)
3. *Develop Indicators for Ecosystem Services and Soil Functions* 88 (R)
- 4. Develop a Distributed Soil Information System** 110 (I)
- 5. Promote the Advantages of Year-Round Soil Cover** 157 (R) (I)
6. *Establish Long-Term Experimental Sites for Diverse Soil Conditions* 96 (R)
7. *Identify Socio-Economic Drivers* 124 (I)
8. *Implement Measures to Address Guidance Gaps* 131 (I)
- 9. Develop Risk Analysis and Management Tools for Policy Guidance** 144 (I)
10. *Develop Guidelines from Long-Term Field Experiments for Regional Knowledge Sharing* 37 (R) (I)
11. *Provide Guidance for Sustainable Soil Management* 60 (I)

12. Establish a Framework for Holistic Data Management 90 (I)
- 13. Implement Holistic Indicators for Soil Type Interpretation 97 (I)**
14. Identify Stakeholders Influencing Soil Health 106 (R)
15. Create Tools and Models for Strategic Integrated Policy Support 116
16. Foster Interdisciplinary Connections 146 (I)
17. Implement Good Practices and Hands-on Education 5 (I)
18. Emphasise Stakeholder Involvement 7 (I)
19. Develop Learning Networks for Stakeholders 33 (I)
20. Advocate Regional Knowledge Adoption Strategies 38 (R) (I)
21. Implement Cost-Effective Long-Term Monitoring of Measures 48 (R) (I)
22. Integrate Prevention and Restoration into Common Policies 49 (R)
23. Enhance Soil Biodiversity Indicators 87 (I)
24. Gather Indicators on Soil Properties 112
25. Establish a Modeling Framework for Soil Mapping 113
26. Establish 'Soil Health' Concept for Ecosystem Assessment 119
27. Assess Government Policy Impact on New Farm System Diffusion 34 (R)
28. Launch Open Monitoring Programs 100
29. Explore Foresight Scenarios for Future Consumption 103 (R)
30. Align with the EU Biodiversity Strategy to Set Concrete Objectives 107 (I)
31. Develop Detailed Soil Geodatabase and Mapping Resources 114
32. Create a Tiered Approach for Harmonising Pan-European Soil Monitoring Indicators 120
33. Integrate Socio-Economic and Biophysical Research 141 (R)
34. Support Innovations Within Living Labs 142 (I)
35. Conduct Resilience Studies of Soil-Plant Systems 145 (R)
36. Collaborate with Horizon Europe Mission on Soil Health and Food Systems 150 (I)
37. Collaborate with Farmers and Communities for Streamlined Approaches 156 (I)
38. Identify and Engage Key Stakeholders 2 (R)
39. Build a Consistent Understanding of Soil Management 45 (R)
40. Explore the Potential of Digital Methods 94 (I)
41. Strive to Reduce Measurement Costs 99 (I)
42. Create Databases on Land Take and Its Impacts 130 (R)
43. Promote Circular Economy Practices in Soil Reuse 132 (I)
44. Define Prevention and Restoration Options for Each Region 47 (I)
45. Develop Holistic Guidance for Soil Lifecycle Management 68 (R) (I)
46. Assess Current Soil Education in Schools 75 (R)
47. Build Capacity for Emerging Soil Scientists 78
48. Review Data Related to Sustainable Environments 108
49. Conduct Comparative Analysis and Harmonise Soil Data Standards 111 (I)
50. Analyse Land Take from a Judicial Perspective 53 (R)
51. Engage Soil Ambassadors 63 (I)
52. Encourage Youth Participation 41 (I)
53. Implement Smart Grazing Practices 44 (I)
54. Simplify Material Reuse 65 (I)
55. Promote Healthy Soil Awareness in Tourism 85 (I)
56. Harmonise Risk Assessment Approaches for Defining 'Acceptable Levels' 122 (R) (I)
57. Focus on Contamination Prevention and Restoration 139 (I)
58. Address Irreversibility in Soil Management 143 (I)
59. Enhance Accounting for Diffuse and Chronic Contamination Sources 123 (I)
60. Prioritise Contaminated Site Management 140 (I)
61. Promote Education on Soil Pollution 66 (I)
62. Focus on Long-Term Monitoring of CoC Effects and Risks 135 (R) (I)

- 63. *Implement a Short Value Chain Approach* 152 (I)
- 64. *Define New Roles for Advisors* 10 (I)
- 65. *Promote Water Harvesting* 25 (R) (I)
- 66. *Establish Criteria for Urban Soil Health* 73 (R)
- 67. *Enhance Regulatory Safety Assessments for Pesticides* 136 (I)
- 68. *Expand Monitoring Beyond Heavy Metals for Comprehensive Risk Management* 121 (R) (I)
- 69. *Implement Gully Control Structures* 24 (R) (I)
- 70. *Encourage Water Reuse* 26 (R) (I)

7.1.6 No net soil sealing and increase the reuse of urban soils

- 1. Develop a Comprehensive Understanding of Soil Properties** 148 (R)
- 2. Engage Stakeholders in Soil Policy and Management Development** 86 (R) (I)
- 3. *Develop Indicators for Ecosystem Services and Soil Functions* 88 (R)
- 4. *Identify Socio-Economic Drivers* 124 (I)
- 5. Implement Measures to Address Guidance Gaps** 131 (I)
- 6. Encourage Cross-Domain Collaboration** 8 (R) (I)
- 7. *Share Successful Experiences* 69 (I)
- 8. *Integrate Prevention and Restoration into Common Policies* 49 (R)
- 9. *Ensure Appropriate Land Use in Suitable Locations* 55 (R)
- 10. *Enhance Soil Biodiversity Indicators* 87 (I)
- 11. *Promote Harmonisation via Methods Exchange* 95 (I)
- 12. *Implement Remote Sensing for Soil Monitoring and Mapping* 115
- 13. *Integrate Soil Functions and Services into Planning Activities* 134 (R) (I)
- 14. *Create Local Policy Frameworks* 54 (I)
- 15. *Address Data Gaps in Soil Health Improvement Measures* 82 (R)
- 16. *Create Methods and Tools for Soil Lifecycle Assessment* 93 (I)
- 17. *Build a Consistent Understanding of Soil Management* 45 (R)
- 18. *Evaluate Current and Future Policy Instruments* 52 (R)
- 19. *Enhance Knowledge Exchange Among Stakeholders* 67 (I)
- 20. *Evaluate Risks and Opportunities in Material Reuse* 137 (R) (I)
- 21. *Develop Restoration Options for Varying Conditions* 17 (I)
- 22. *Consider Incentives for Ecosystem Services* 57 (I)
- 23. *Create Frameworks for Prevention and Compensation* 64 (I)
- 24. *Create Databases on Land Take and Its Impacts* 130 (R)
- 25. *Promote Circular Economy Practices in Soil Reuse* 132 (I)
- 26. *Develop Holistic Guidance for Soil Lifecycle Management* 68 (R) (I)
- 27. *Develop Indicators for Land Take and Soil Sealing Dynamics* 92 (I)
- 28. *Analyse Land Take from a Judicial Perspective* 53 (R)
- 29. *Define Intermediate Steps and Realistic Objectives* 61 (I)
- 30. *Develop Topic-Specific Funding Schemes* 50 (R)
- 31. *Prioritise Contaminated Site Management* 140 (I)
- 32. *Enhance Regulatory Flexibility* 59
- 33. *Strengthen Urban-Rural Linkages* 153 (I)

7.1.7 Improve soil structure

- 1. Develop a Comprehensive Understanding of Soil Properties** 148 (R)
- 2. Engage Stakeholders in Soil Policy and Management Development** 86 (R) (I)
- 3. *Develop Indicators for Ecosystem Services and Soil Functions* 88 (R)
- 4. *Identify Socio-Economic Drivers* 124 (I)

- 5. Implement Measures to Address Guidance Gaps 131 (I)**
- 6. Encourage Cross-Domain Collaboration 8 (R) (I)**
7. Share Successful Experiences 69 (I)
8. Integrate Prevention and Restoration into Common Policies 49 (R)
9. Ensure Appropriate Land Use in Suitable Locations 55 (R)
10. Enhance Soil Biodiversity Indicators 87 (I)
11. Promote Harmonization via Methods Exchange 95 (I)
12. Implement Remote Sensing for Soil Monitoring and Mapping 115
13. Integrate Soil Functions and Services into Planning Activities 134 (R) (I)
14. Create Local Policy Frameworks 54 (I)
15. Address Data Gaps in Soil Health Improvement Measures 82 (R)
16. Create Methods and Tools for Soil Lifecycle Assessment 93 (I)
17. Build a Consistent Understanding of Soil Management 45 (R)
18. Evaluate Current and Future Policy Instruments 52 (R)
19. Enhance Knowledge Exchange Among Stakeholders 67 (I)
20. Evaluate Risks and Opportunities in Material Reuse 137 (R) (I)
21. Develop Restoration Options for Varying Conditions 17 (I)
22. Consider Incentives for Ecosystem Services 57 (I)
23. Create Frameworks for Prevention and Compensation 64 (I)
24. Create Databases on Land Take and Its Impacts 130 (R)
25. Promote Circular Economy Practices in Soil Reuse 132 (I)
26. Develop Holistic Guidance for Soil Lifecycle Management 68 (R) (I)
27. Develop Indicators for Land Take and Soil Sealing Dynamics 92 (I)
28. Analyse Land Take from a Judicial Perspective 53 (R)
29. Define Intermediate Steps and Realistic Objectives 61 (I)
30. Prioritise Contaminated Site Management 140 (I)
31. Enhance Regulatory Flexibility 59
32. Strengthen Urban-Rural Linkages 153 (I)

7.1.8 Increase soil literacy in Member States

- 1. Develop a Comprehensive Understanding of Soil Properties 148 (R)**
- 2. Engage Stakeholders in Soil Policy and Management Development 86 (R) (I)**
3. Develop Indicators for Ecosystem Services and Soil Functions 88 (R)
- 4. Develop a Distributed Soil Information System 110 (I)**
- 5. Promote the Advantages of Year-Round Soil Cover 157 (R) (I)**
6. Establish Long-Term Experimental Sites for Diverse Soil Conditions 96 (R)
7. Identify Socio-Economic Drivers 124 (I)
- 8. Implement Measures to Address Guidance Gaps 131 (I)**
- 9. Develop Risk Analysis and Management Tools for Policy Guidance 144 (I)**
10. Expand Knowledge of Erosion 14 (R)
11. Share Successful Experiences 69 (I)
12. Establish a Framework for Holistic Data Management 90 (I)
13. Identify Stakeholders Influencing Soil Health 106 (R)
14. Foster Interdisciplinary Connections 146 (I)
15. Collaborate with Stakeholders and Member States to Promote Education 4 (I)
16. *Implement Good Practices and Hands-on Education 5 (I)*
17. *Develop Learning Networks for Stakeholders 33 (I)*
18. *Advocate Regional Knowledge Adoption Strategies 38 (R) (I)*
19. *Integrate Prevention and Restoration into Common Policies 49 (R)*
20. *Ensure Appropriate Land Use in Suitable Locations 55 (R)*

21. *Enhance Soil Biodiversity Indicators 87 (I)*
22. *Promote Harmonisation via Methods Exchange 95 (I)*
23. *Implement Remote Sensing for Soil Monitoring and Mapping 115*
24. *Integrate Soil Functions and Services into Planning Activities 134 (R) (I)*
25. *Create Local Policy Frameworks 54 (I)*
26. *Address Data Gaps in Soil Health Improvement Measures 82 (R)*
27. *Create Methods and Tools for Soil Lifecycle Assessment 93 (I)*
28. *Build a Consistent Understanding of Soil Management 45 (R)*
29. *Evaluate Current and Future Policy Instruments 52 (R)*
30. *Enhance Knowledge Exchange Among Stakeholders 67 (I)*
31. *Evaluate Risks and Opportunities in Material Reuse 137 (R) (I)*
32. *Develop Restoration Options for Varying Conditions 17 (I)*
33. *Consider Incentives for Ecosystem Services 57 (I)*
34. *Create Frameworks for Prevention and Compensation 64 (I)*
35. *Create Databases on Land Take and Its Impacts 130 (R)*
36. *Promote Circular Economy Practices in Soil Reuse 132 (I)*
37. *Develop Holistic Guidance for Soil Lifecycle Management 68 (R) (I)*
38. *Develop Indicators for Land Take and Soil Sealing Dynamics 92 (I)*
39. *Analyse Land Take from a Judicial Perspective 53 (R)*
40. *Define Intermediate Steps and Realistic Objectives 61 (I)*
41. *Prioritise Contaminated Site Management 140 (I)*
42. *Enhance Regulatory Flexibility 59*
43. *Strengthen Urban-Rural Linkages 153 (I)*

7.1.9 Nature conservation of soil biodiversity

- 1. Develop a Comprehensive Understanding of Soil Properties 148 (R)**
- 2. Explore Diverse Sustainable Land Management Strategies 154 (R)**
- 3. Engage Stakeholders in Soil Policy and Management Development 86 (R) (I)**
4. *Develop Indicators for Ecosystem Services and Soil Functions 88 (R)*
- 5. Develop a Distributed Soil Information System 110 (I)**
- 6. Promote the Advantages of Year-Round Soil Cover 157 (R) (I)**
- 7. Identify Socio-Economic Drivers 124 (I)**
- 8. Implement Measures to Address Guidance Gaps 131 (I)**
- 9. Develop Risk Analysis and Management Tools for Policy Guidance 144 (I)**
10. *Expand Knowledge of Erosion 14 (R)*
11. *Share Successful Experiences 69 (I)*
12. *Establish a Framework for Holistic Data Management 90 (I)*
13. *Identify Stakeholders Influencing Soil Health 106 (R)*
- 14. Foster Interdisciplinary Connections 146 (I)**
15. *Collaborate with Stakeholders and Member States to Promote Education 4 (I)*
16. *Implement Good Practices and Hands-on Education 5 (I)*
17. *Develop Learning Networks for Stakeholders 33 (I)*
18. *Advocate Regional Knowledge Adoption Strategies 38 (R) (I)*
19. *Integrate Prevention and Restoration into Common Policies 49 (R)*
20. *Ensure Appropriate Land Use in Suitable Locations 55 (R)*
21. *Enhance Soil Biodiversity Indicators 87 (I)*
22. *Promote Harmonisation via Methods Exchange 95 (I)*
23. *Implement Remote Sensing for Soil Monitoring and Mapping 115*
24. *Integrate Soil Functions and Services into Planning Activities 134 (R) (I)*
25. *Create Local Policy Frameworks 54 (I)*

26. Address Data Gaps in Soil Health Improvement Measures 82 (R)
27. Create Methods and Tools for Soil Lifecycle Assessment 93 (I)
28. Build a Consistent Understanding of Soil Management 45 (R)
29. Evaluate Current and Future Policy Instruments 52 (R)
30. Enhance Knowledge Exchange Among Stakeholders 67 (I)
31. Evaluate Risks and Opportunities in Material Reuse 137 (R) (I)
32. Develop Restoration Options for Varying Conditions 17 (I)
33. Consider Incentives for Ecosystem Services 57 (I)
34. Create Frameworks for Prevention and Compensation 64 (I)
35. Create Databases on Land Take and Its Impacts 130 (R)
36. Promote Circular Economy Practices in Soil Reuse 132 (I)
37. Develop Holistic Guidance for Soil Lifecycle Management 68 (R) (I)
38. Develop Indicators for Land Take and Soil Sealing Dynamics 92 (I)
39. Analyse Land Take from a Judicial Perspective 53 (R)
40. Define Intermediate Steps and Realistic Objectives 61 (I)
41. Prioritise Contaminated Site Management 140 (I)
42. Enhance Regulatory Flexibility 59
43. Strengthen Urban-Rural Linkages 153 (I)
44. Promote Local Erosion Control Planning 18 (I)
45. Promote Harmonization and Standardization 30 (R) (I)
46. Promote Rainwater Retention 23 (R) (I)
47. Enhance Regulatory Safety Assessments for Pesticides 136 (I)
48. Implement Targeted Erosion Mitigation Measures 31 (I)
49. Assess Unsuitable Soils 21 (R)
50. Establish Science-to-Science Networks 35 (I)
51. Harmonise Risk Assessment Approaches for Defining 'Acceptable Levels' 122 (R) (I)
52. Address Irreversibility in Soil Management 143 (I)

7.2 Selected actions from the literature review

Table 3: Selected options from the manual literature review

No	Option Title	Short Description	social	technical	economic	Source
1	Enhance Stakeholder Awareness and Explore Alternatives	Develop awareness-raising materials for all stakeholder types and demonstrate sustainable alternatives and their profitability.	X	X		Ittner and Nauman, 2022a
2	Identify and Engage Key Stakeholders	Identify key stakeholders, understand their roles, and determine their awareness and communication channels at different levels.	X			Ittner and Naumann, 2022a

No	Option Title	Short Description	social	technical	economic	Source
3	Improve Educational Programs for Stakeholders	Identify current channels, practices, values, and concerns of key stakeholder groups and citizens to inform educational programs.	X			Ittner and Naumann, 2022a
4	Collaborate with Stakeholders and Member States to Promote Education	Co-develop effective education programs, toolkits, and engagement measures for different education levels in collaboration with targeted stakeholders and Member States, addressing stakeholder needs as well as local opportunities and solutions.	X	X		Ittner and Naumann, 2022a
5	Implement Good Practices and Hands-on Education	Enhance co-creation and multidirectional learning in communities of practice, including the demonstration of good practices and hands-on education.	X			Ittner and Naumann, 2022a
6	Develop Comprehensive Communication Strategies	Create a transparent communication platform and system that incorporates various communication channels and methodologies, such as storytelling.		X		Ittner and Naumann, 2022a
7	Emphasise Stakeholder Involvement	Develop methods for stakeholder involvement that address co-design, co-implementation, and co-assessment (citizen science) of both problems and solutions.	X			Ittner and Naumann, 2022a
8	Encourage Cross-Domain Collaboration	Identify and establish networks and coalitions to foster collaboration and facilitate the exchange of knowledge at EU and global levels for ongoing monitoring and evaluation of progress.	X			Keesstra et al. 2021
9	Raise Awareness of Soil Literacy Among Stakeholders	Implement capacity-building and education initiatives, as well as the establishment of living labs, to raise awareness of soil literacy among stakeholders.	X			Bayer et al. 2023
10	Define New Roles for Advisors	Focus on digitalisation and the assignment of new roles to advisors, such as facilitators and intermediaries.		X		Bayer et al. 2023

No	Option Title	Short Description	social	technical	economic	Source
11	Enhance Collaboration with Ongoing Initiatives	Collaborate on soil projects and ongoing initiatives that focus on the adoption of climate-smart sustainable agricultural soil management practices.		X		
12	Establish a Transparent and Adaptive Monitoring System	Design a transparent and adaptive monitoring system to support continuous learning and accountability.		X		Verhagen et al. 2022
13	Continuous Assessment and Adaptation	Periodically reassess goals and instruments, adjusting goals and pathways for learning and accountability as appropriate.			X	Verhagen et al. 2022
14	Expand Knowledge of Erosion	Study and determine the effects, trade-offs, and synergies of erosion, focusing on land and water management practices, water provision, and the future impact of climate change on vegetation, soil functions, and ecosystem services from plot to catchment scale.			X	Ittner and Naumann, 2022a
15	Explore Methods to Mitigate Erosion Risk	Investigate the role of soil hydrology and functions, such as infiltration capacity, in reducing the risk of water erosion, which is particularly important following heavy rains and mild winters in northern regions.		X		Ittner and Naumann, 2022a
16	Incorporate Socio-Economic Impacts of Erosion into Budgeting	Examine the socio-economic impacts, trade-offs, and synergies of erosion, including the organic carbon fluxes induced by soil erosion, to be included in regional and national greenhouse gas emission budgets.	X		X	Ittner and Naumann, 2022a
17	Develop Restoration Options for Varying Conditions	Focus on developing and testing restoration options in eroded landscapes or areas at risk of erosion across different pedo-climatic zones under various land uses.		X	X	Ittner and Naumann, 2022a
18	Promote Local Erosion Control Planning	Develop tools for local erosion control planning that include trade-offs of land and water management choices at both plot		X		Ittner and Naumann, 2022a

No	Option Title	Short Description	social	technical	economic	Source
		and landscape levels, utilising remote sensing and on-site measurements.				
19	Present Comprehensive Erosion Processes Affordably	Create monitoring and modeling tools that can assess the entire erosion process (detachment, transport, and deposition) in a cost-effective yet precise manner, including the effects of land management options.		X	X	Ittner and Naumann, 2022a
20	Integrate and Provide Soil Management Strategy Maps	Provide maps that illustrate the applicability and relevance of sustainable soil management strategies to mitigate soil erosion, tailored to various land use sectors such as agriculture, forestry, nature, industry, mining, and urban areas, for integration into policy tools.		X	X	Ittner and Naumann, 2022a
21	Assess Unsuitable Soils	Encourage the regrowth and development of potential vegetation in unsuitable soils, particularly in grazing areas on high slopes.			X	Bayer et al. 2023
22	Enhance Soil Water Retention Capacity	Adapt soil management practices, such as no-till and improving soil structures, to increase the water retention capacity of soils.		X	X	Bayer et al. 2023
23	Promote Rainwater Retention	Emphasise that keeping precipitation in place is crucial, as demonstrated by a local initiative where farmers have started a small water retention project as a pilot.		X	X	Bayer et al. 2023
24	Implement Gully Control Structures	Focus on the restoration of existing gullies in the field.		X		Gómez et al. 2021
25	Promote Water Harvesting	Utilise techniques aimed at concentrating and storing surface or subsurface runoff for crop use.		X	X	Gómez et al. 2021

No	Option Title	Short Description	social	technical	economic	Source
26	Encourage Water Reuse	Promote the reuse of water that has been used in prior activities.		X	X	Gómez et al. 2021
27	Boost Soil Water Holding Capacity	Modify soil properties to improve water infiltration and increase soil water storage capacity.		X		Gómez et al. 2021
28	Conduct Plot-Scale Soil Observations	Observe landscape features on farms, such as slopes, rivers, and woodlands, to gather useful information on soil-water status, which can guide management decisions regarding preferential flow paths and potential wetlands, while promoting good agricultural practices to prevent soil erosion.		X		SoilCare, 2021
29	Address Soil Compaction from Unsuitable Agricultural Practices	Mitigate soil compaction caused by heavy machinery, such as tractors, which leads to erosion and restricts vital biological activity. Adjusted tilling practices or soil cultivation can aid in soil recovery.		X		SoilCare, 2021
30	Promote Harmonisation and Standardisation	Facilitate the harmonisation and parameterisation of erosion models to ensure consistent soil erosion assessments, improve management efficiency, and strengthen policy initiatives aimed at tackling soil erosion within the European Union.		X	X	Schmaltz and Johannsen, 2024
31	Implement Targeted Erosion Mitigation Measures	Emphasise that erosion mitigation measures should be specifically applied in areas at heightened risk of erosion, enhancing effectiveness by promoting voluntary measures while instituting mandatory measures when necessary.		X		Schmaltz and Johannsen, 2024
32	Improve Sediment Connectivity Modeling	Highlight the strong link between sediment connectivity and erosion risk maps, recommending the validation of these maps through empirical data that is tailored to meet regional conditions for enhanced reliability and sustainability.		X		Schmaltz and Johannsen, 2024

No	Option Title	Short Description	social	technical	economic	Source
33	Develop Learning Networks for Stakeholders	Establish learning networks of farmers and researchers across all agro-ecological zones to experiment and collaborate on innovations.	X	X		Keesstra et al. 2021
34	Assess Government Policy Impact on New Farm System Diffusion	Evaluate the impact of European and national policies on the potential benefits and trade-offs of new farm system approaches and the enabling conditions required for their adoption.	X		X	Keesstra et al. 2021
35	Establish Science-to-Science Networks	Seek to better align scientific communities across Europe and beyond.		X	X	Keesstra et al. 2021
36	Explore Regionally-Based Co-Innovation and Management Strategies	Generate situated and context-dependent assessments of the challenges farmers face, accounting for the diversity in the agricultural sector, including social and cultural challenges related to soil management, and fostering improved soil management through strengthened regional research networks.	X		X	Keesstra et al. 2021
37	Develop Guidelines from Long-Term Field Experiments for Regional Knowledge Sharing	Emphasise the need for regional long-term field experiments to test and assess ideas, providing quantified information about the consequences of management strategies. Specific guidelines and tools can be developed from these experiments, which should be complemented by demonstration activities at commercial Lighthouse Farms.	X	X		Keesstra et al. 2021
38	Advocate Regional Knowledge Adoption Strategies	Highlight that farmers who are likely to teach or inspire others have greater legitimacy, making regional approaches for knowledge adoption more effective than general European approaches. Identifying the best communication channels and pathways between end-users and scientists is essential to enable co-innovation and the adoption of sustainable agricultural practices adapted to regional conditions.	X	X		Keesstra et al. 2021

No	Option Title	Short Description	social	technical	economic	Source
39	Facilitate Science-Policy Dialogues	Identify barriers and research needs, such as cost-effective monitoring systems and farmer-citizen initiatives, to enhance approaches to soil management and close the gap between national, regional, and local monitoring through citizen science.	X	X	X	Keesstra et al. 2021
40	Promote Small-Scale Sustainable Agricultural Initiatives	Focus on small-scale initiatives that stimulate sustainable agriculture, such as decreasing the use of heavy machinery, increasing crop diversity, and utilising animal manure instead of synthetic fertilizers.			X	Bayer et al. 2023
41	Encourage Youth Participation	Seek to encourage young people to become involved in new, healthier agricultural practices.	X			Bayer et al. 2023
42	Empower Farmers' Self-Determination	Emphasise that farmers desire self-determination and should not be overly regulated or burdened by bureaucracy in their activities.	X		X	Bayer et al. 2023
43	Enhance Communication and Implementation Potential	Recognise the appreciation of workshop participants for agricultural policy efforts while emphasising the need for improved communication and implementation methods.	X	X		Bayer et al. 2023
44	Implement Smart Grazing Practices	Provide training for farmers in intelligent, sustainable, and regenerative grazing practices.	X			Bayer et al. 2023
45	Build a Consistent Understanding of Soil Management	Aim to develop proper definitions of land degradation relevant to different land uses and sectors.	x			Ittner and Naumann, 2022a
46	Assess Driving Factors in Short, Medium, and Long Terms	Seek to assess and model the impacts of climate change and other drivers on land degradation across Europe in short, medium, and long terms.	X			Ittner and Naumann, 2022a

No	Option Title	Short Description	social	technical	economic	Source
47	Define Prevention and Restoration Options for Each Region	Identify suitable prevention and restoration options for land degradation while assessing trade-offs for different land use types and pedo-climatic conditions within the EU.			X	Ittner and Naumann, 2022a
48	Implement Cost-Effective Long-Term Monitoring of Measures	Establish and evaluate long-term records of prevention and restoration measures for various land use systems, with a focus on cost-effectiveness.			X	Ittner and Naumann, 2022a
49	Integrate Prevention and Restoration into Common Policies	Mainstream the prevention and restoration of land degradation as a priority action across all policies, including various incentive schemes.	X			Ittner and Naumann, 2022a
50	Develop Topic-Specific Funding Schemes	Analyse the effectiveness and trade-offs of various funding schemes.			X	Ittner and Naumann, 2022a
51	Assess Public Support for Soil Organic Carbon	Identify priority areas where public support for improving Soil Organic Carbon is most needed and develop subsidy frameworks for carbon sequestration.	X		X	Ittner and Naumann, 2022a
52	Evaluate Current and Future Policy Instruments	Focus on evaluating the effectiveness of existing and future policy instruments, including models for projected policy outputs and considering economic impacts.			X	Ittner and Naumann, 2022a
53	Analyse Land Take from a Judicial Perspective	Identify and assess the legal and socio-economic dimensions of land take across Member States.	X		X	Ittner and Naumann, 2022a
54	Create Local Policy Frameworks	Develop decision frameworks for local policymakers to evaluate development plans and ecosystem service delivery.	X			Ittner and Naumann, 2022a
55	Ensure Appropriate Land Use in Suitable Locations	Evaluate land use change options to determine the most suitable land use or land use combination for each location.			X	Ittner and Naumann, 2022a

No	Option Title	Short Description	social	technical	economic	Source
56	Promote Land Use Specification in Legislation	Seek to consider the diverse and variable range of land uses in production systems within policy objectives, measures, legislation, and certification systems.			X	Ittner and Naumann, 2022a
57	Consider Incentives for Ecosystem Services	Emphasise that measures, except for carbon sequestration, are currently based on voluntary actions, and that rewarding ecosystem services can stimulate sustainable land use through subsidies and policies.	X		X	Bayer et al. 2023
58	Highlight Benefits of a Diversified Product Portfolio	Illustrate that a diversified product portfolio can serve as an adaptation strategy to meet societal consumption preferences and protect against price shocks.	X		X	Bayer et al. 2023
59	Enhance Regulatory Flexibility	Stress the importance of maintaining flexibility in regulations related to subsidies.			X	Bayer et al. 2023
60	Provide Guidance for Sustainable Soil Management	Address the current lack of clarity regarding the development of sustainable soil management practices by Member States and emphasise the need for further elaboration on linking practices to principles outlined in the proposed Directive.	X	X		Wageningen University and Research, 2023
61	Define Intermediate Steps and Realistic Objectives	Focus on the importance of defining intermediary objectives to achieve the target of 100% healthy soils across Europe by 2050, highlighting the necessity of setting clear intermediate targets based on past experiences.			X	Wageningen University and Research, 2023
62	Evaluate Tailored Education for Diverse Stakeholder Groups	Develop and test tailored educational materials to raise awareness about the benefits of functional/unsealed soils, green infrastructure, nature-based solutions, and preventing measures for various target groups, as well as the potential of a nature-based economy for local and regional economic development.	X		X	Ittner and Naumann, 2022a

No	Option Title	Short Description	social	technical	economic	Source
63	Engage Soil Ambassadors	Identify and engage soil ambassadors at different levels to promote soil health.	X			Ittner and Naumann, 2022a
64	Create Frameworks for Prevention and Compensation	Develop effective framework programs and economic tools, such as taxes, incentives, and eco-budgeting schemes, to prevent soil sealing or compensate for its impacts.			X	Ittner and Naumann, 2022a
65	Simplify Material Reuse	Identify methods and approaches to reduce the risks associated with the reuse of materials, including sand, clay, gravel, biochar, and compost, while considering testing, cleaning, monitoring, financial, legal, and governance aspects.		X	X	Ittner and Naumann, 2022a
66	Promote Education on Soil Pollution	Develop educational materials and professional training on the effects and prevention of soil pollution for various stakeholder groups, including schools and citizens.	X			Ittner and Naumann, 2022a
67	Enhance Knowledge Exchange Among Stakeholders	Develop methods to increase knowledge exchange between member states and organisations with varying levels of experience in remediation techniques, soil restoration, and brownfield management.	X		X	Ittner and Naumann, 2022a
68	Develop Holistic Guidance for Soil Lifecycle Management	Provide guidance to Member States on setting remediation targets, prioritising polluted sites, reusing materials, and drafting soil management strategies.	X	X		Ittner and Naumann, 2022a
69	Share Successful Experiences	Identify and communicate success stories, such as those shared via Lighthouses, to showcase the benefits of soil health for both soil managers' incomes and society.	X		X	Ittner and Naumann, 2022a
70	Disseminate Innovative Practices and Technologies to Land Managers	Develop training initiatives and identify soil ambassadors to assist land managers and soil users in adopting new management practices and applying new technologies that improve soil structure.	X	X	X	Ittner and Naumann, 2022a

No	Option Title	Short Description	social	technical	economic	Source
71	Improve Understanding of Soil Degradation Impacts	Conduct research to better understand the impacts of soil degradation on social security, food security, and human health.	X		X	Ittner and Naumann, 2022a
72	Investigate General Knowledge about Soil Services	Develop and implement a methodology to gain insights into citizens' and key stakeholders' knowledge about soil services and their benefits.	X			Ittner and Naumann, 2022a
73	Establish Criteria for Urban Soil Health	Focus on defining urban soil health, specifically distinguishing between various urban land uses.	X			
74	Enhance Dissemination of New Knowledge Through Existing Channels	Analyse how new knowledge about soil health can be effectively disseminated through identified channels.		X		Ittner and Naumann, 2022a
75	Assess Current Soil Education in Schools	Aim to assess the current state of soil education in school curricula at all levels and to monitor any changes over time.	X			Ittner and Naumann, 2022a
76	Promote Soil Literacy in Higher Education	Co-develop soil literacy courses in relevant academic programs, such as agronomy, environmental sciences, and environmental engineering, for universities.	X			Ittner and Naumann, 2022a
77	Engage Key Stakeholders and Citizens	Develop communication tools for close cooperation with key stakeholders and citizens to raise awareness of soil health and best management practices, informing various stakeholders about the benefits provided by soils.	X			Ittner and Naumann, 2022a
78	Build Capacity for Emerging Soil Scientists	Enhance the capacity of the next generation of soil scientists through targeted training and support.			X	Keesstra et al. 2021
79	Compile and Distribute Best Practices	Review the Rural Development Programme and eco-schemes under the Common Agricultural Policy (CAP) to promote sustainable soil management,	X		X	Keesstra et al. 2021

No	Option Title	Short Description	social	technical	economic	Source
		including the development and documentation of soil quality indicators and the use of incentives for adopting sustainable practices.				
80	Centralise Information from EU Soil Mission Initiatives and Citizen Engagement	Establish a website that serves as an online community, offering engagement and training through a one-stop-shop platform that equips stakeholders with tailored digital networking tools for connection and exchange, improves access to quality resources, and promotes virtual interaction on social innovation and soil education.	X			Gómez Grande, 2023
81	Facilitate Knowledge Transfer and Co-Creation in Living Labs and Lighthouses	Identify and support key actions and innovations in living labs and lighthouses, including the mapping of current and emerging initiatives, co-designing business plans, and prioritising specific soil needs for knowledge transfer and co-creation.	X	X		Gómez Grande, 2023
82	Address Data Gaps in Soil Health Improvement Measures	Focus on identifying knowledge demands regarding soil health improvement measures, such as cover crops in high altitudes, bio-manure applications, biochar applications, and the status of soil health.		X		Bayer et al. 2023
83	Explore Urban Living Lab Opportunities	Invest in urban living labs to enhance knowledge and improve soil health.	X	X		Bayer et al. 2023
84	Foster Cross-Topic Connections	Aim to connect with other topics to mainstream or integrate climate change adaptation into various workflows, recognising that most soil management activities will be impacted by climate change.	X			
85	Promote Healthy Soil Awareness in Tourism	Emphasise the importance of public awareness regarding healthy soil and organic fertilizers in tourism development.	X			Bayer et al. 2023

No	Option Title	Short Description	social	technical	economic	Source
86	Engage Stakeholders in Soil Policy and Management Development	Ensure the early involvement of stakeholders in the development of national soil monitoring programs to promote acceptance and shared interest in indicators, reference values, and target values for soil quality, incorporating practical knowledge on land management and the potential for payments for ecosystem services.	X		X	Faber et al. 2022
87	Enhance Soil Biodiversity Indicators	Develop an improved indicator for assessing soil biodiversity that captures comprehensive data on sensitivity to environmental changes and requires Member States to include at least three additional biological indicators.		X		Wageningen University and Research, 2023
88	Develop Indicators for Ecosystem Services and Soil Functions	Create indicators that directly evaluate ecosystem service capacity and measure the benefits of sustainable soil management practices, enhancing relevance and alignment with EU Green Deal strategies.		X		Wageningen University and Research, 2023
89	Reevaluate the 'One Out - All Out' Principle	Review the 'One out - all out' principle to ensure that assessments of soil health are not misleading by incorporating multiple indicators and contextual information.		X		Wageningen University and Research, 2023
90	Establish a Framework for Holistic Data Management	Create a framework featuring easily measurable, cost-effective indicators that include early-warning signals and thresholds for various types of soil degradation.		X	X	Ittner and Naumann, 2022a
91	Address Nutrient Management Related to Soil Organic Carbon	Investigate the effects of different nutrient management systems on Soil Organic Carbon across a range of agricultural systems.		X		Ittner and Naumann, 2022a
92	Develop Indicators for Land Take and Soil Sealing Dynamics	Develop and test indicators for mapping and monitoring land take and soil sealing dynamics, along with their effects on soil functions and services.		X		Ittner and Naumann, 2022a

No	Option Title	Short Description	social	technical	economic	Source
93	Create Methods and Tools for Soil Lifecycle Assessment	Explore and develop effective methods and tools to analyse soil quality and track soil transport, including the creation of new soils from excavated materials and organic wastes.		X		Ittner and Naumann, 2022a
94	Explore the Potential of Digital Methods	Assess the potential of digital transformation and develop innovative sensing methods and tools for soil management.		X		Ittner and Naumann, 2022a
95	Promote Harmonisation via Methods Exchange	Facilitate the exchange of monitoring and mapping methods through various initiatives to ensure harmonisation of these methods across Europe.		X		Ittner and Naumann, 2022a
96	Establish Long-Term Experimental Sites for Diverse Soil Conditions	Develop and support long-term experimental research sites to study soil properties and functioning across different land uses and climatic conditions.		X		Ittner and Naumann, 2022a
97	Implement Holistic Indicators for Soil Type Interpretation	Develop and test indicators to assess soil structure and biodiversity for various soil types, establishing benchmark values linked to crop health.		X		Ittner and Naumann, 2022a
98	Develop Measurement Protocols for Various Use Cases	Create and test different measurement protocols for various land uses, soil types, and climatic conditions in collaboration with end-users.		X	X	Ittner and Naumann, 2022a
99	Strive to Reduce Measurement Costs	Promote the development of commercial laboratories and accessible protocols to enable low-cost measurement of soil indicators.			X	Ittner and Naumann, 2022a
100	Launch Open Monitoring Programs	Install monitoring programs at various scales (EU, national, local) to assess soil and crop status and health, ensuring data is collected, centralised, and accessible for monitoring progress.		X	X	Ittner and Naumann, 2022a

No	Option Title	Short Description	social	technical	economic	Source
101	Define an EU Soil Footprint	Establish clear research questions and problem statements to clarify the aim of developing an EU soil footprint.		X	X	Ittner and Naumann, 2022a
102	Create a Common Global Soil Footprint	Develop a holistic definition, including ontologies, indicators, baseline data, and standards for a global footprint on soils and soil health.		X		Ittner and Naumann, 2022a
103	Explore Foresight Scenarios for Future Consumption	Develop foresight scenarios to analyse future consumption patterns and production models, focusing on the global soil health impacts of EU activities.		X		Ittner and Naumann, 2022a
104	Assess Policy Impacts on Soil Footprints	Evaluate the impact of EU and global policies, including trade and market policies, on the EU global soil footprint.		X	X	Ittner and Naumann, 2022a
105	Investigate New Policy Instrument Opportunities	Explore new holistic policy instruments and mechanisms designed to reduce trade-offs and negative impacts on the global soil footprint.			X	Ittner and Naumann, 2022a
106	Identify Stakeholders Influencing Soil Health	Identify sectors, agents, and relevant policies that impact soil health both within the EU and beyond.			X	Ittner and Naumann, 2022a
107	Align with the EU Biodiversity Strategy to Set Concrete Objectives	Seek synergies with the EU Biodiversity Strategy and the Convention on Biological Diversity to develop methods and standards for describing soil biodiversity in terms of services and sustainable use.			X	Keesstra et al. 2021
108	Review Data Related to Sustainable Environments	Review international research agendas related to sustainable environments, including integration with various directives and targets.			X	Keesstra et al. 2021
109	Evaluate Current Soil Data Sharing	Conduct a stocktaking of European and national legislation regarding soil data sharing.		X	X	Keesstra et al. 2021

No	Option Title	Short Description	social	technical	economic	Source
110	Develop a Distributed Soil Information System	Create an easy-to-update distributed soil information system that links sharable national data from EU members according to INSPIRE and allows querying through a portal.		X		Keesstra et al. 2021
111	Conduct Comparative Analysis and Harmonise Soil Data Standards	Compile international and national code lists and vocabularies for INSPIRE, resolve impediments, and provide workflows for implementation and data sharing.		X		Keesstra et al. 2021
112	Gather Indicators on Soil Properties	Conduct a stocktaking of indicators for assessing soil quality, functionality, and ecosystem services in relation to existing calls.		X		Keesstra et al. 2021
113	Establish a Modeling Framework for Soil Mapping	Research and define threshold values for modeling soil functions and threats in collaboration with relevant organisations.		X		Keesstra et al. 2021
114	Develop Detailed Soil Geodatabase and Mapping Resources	Deliver thematic soil geodatabases and maps at a 1 km resolution, including data on soil properties and functional characteristics.		X		Keesstra et al. 2021
115	Implement Remote Sensing for Soil Monitoring and Mapping	Conduct research on the use of remote and proximal sensing for monitoring and mapping soil management.		X		Keesstra et al. 2021
116	Create Tools and Models for Strategic Integrated Policy Support	Combine multiple soil challenges and measures, using agroecosystem models to understand the systemic effects of new measures, while considering costs and benefits.		X		Keesstra et al. 2021
117	Assess Monitoring and Soil Health Indicators for Gaps and Training Needs	Evaluate the indicators proposed for monitoring soil health, focusing on consolidating the monitoring framework and defining training needs.		X		Gómez Grande, 2023

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118	Avoid Sole Dependence on Laboratory Results for Soil Observations	Ensure that laboratory diagnoses are complemented by field assessments for efficient soil diagnosis, utilising various tests to enhance accuracy.		X		SoilCare, 2021
119	Establish 'Soil Health' Concept for Ecosystem Assessment	Promote soil quality monitoring and develop soil data usage in national ecosystem assessments, defining references and target values in context with soil type and land use.		X		Faber et al. 2022
120	Create a Tiered Approach for Harmonising Pan-European Soil Monitoring Indicators	Develop a modular system of soil quality indicators that addresses specific soil threats and trade-offs, facilitating a pragmatic approach to monitoring.		X		Faber et al. 2022
121	Expand Monitoring Beyond Heavy Metals for Comprehensive Risk Management	Broaden the obligatory monitoring for contamination to include a range of chemical and biological hazards beyond heavy metals.		X		Wageningen University and Research, 2023
122	Harmonise Risk Assessment Approaches for Defining 'Acceptable Levels'	Improve the consistency of risk assessment tools to maintain contamination risks at acceptable levels, considering environmental, social, and economic impacts.		X	X	Wageningen University and Research, 2023
123	Enhance Accounting for Diffuse and Chronic Contamination Sources	Distinguish between local and diffuse pollution sources, ensuring systematic monitoring and risk assessment for diffuse contamination.			X	Wageningen University and Research, 2023
124	Identify Socio-Economic Drivers	Identify and assess the socio-economic drivers for land degradation and related desertification processes across various scales.	X		X	Ittner and Naumann, 2022a
125	Identify Vulnerable Areas in the EU and Assess Influences	Take stock of desertification processes occurring in the EU and assess how vulnerable areas will change in the future	X		X	Ittner and Naumann, 2022a

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		due to climate change and biodiversity loss.				
126	Develop Unified Methods and Indicators for Soil Organic Carbon Monitoring	Create harmonised methods and indicators to monitor changes in Soil Organic Carbon in various agricultural systems and identify factors that stabilise SOC.		X		Ittner and Naumann, 2022a
127	Identify Optimal Conditions for Soil Organic Carbon Sequestration and Storage	Determine the ability of different soils to sequester and store Soil Organic Carbon under varying climate conditions.		X		Ittner and Naumann, 2022a
128	Assess Regional Potential for Soil Organic Carbon Storage	Establish a baseline for current Soil Organic Carbon stocks and develop guidelines to promote SOC storage in different management and climatic conditions.			X	Ittner and Naumann, 2022a
129	Develop Business Models for Carbon Trading	Identify and develop business models for different sectors to provide a financial basis for trading carbon, focusing on the economic effects of increased SOC sequestration and losses.			X	Ittner and Naumann, 2022a
130	Create Databases on Land Take and Its Impacts	Develop and promote databases for land consumption and associated environmental effects, informing policy processes across various scales.		X	X	Ittner and Naumann, 2022a
131	Implement Measures to Address Guidance Gaps	Identify, assess, and demonstrate measures to reduce or prevent soil sealing, rehabilitate contaminated soils, and increase water infiltration through nature-based solutions.		X	X	Ittner and Naumann, 2022a
132	Promote Circular Economy Practices in Soil Reuse	Explore the potential and benefits of combining circular economy approaches with soil reuse, assessing trade-offs and impacts.		X	X	Ittner and Naumann, 2022a

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133	Enhance Governance Effectiveness and Transparency	Develop new governance models and co-creation approaches for integrated urban planning, improving acceptance of innovation and fostering collaboration.	X			Ittner and Naumann, 2022a
134	Integrate Soil Functions and Services into Planning Activities	Develop guidelines for weighing and integrating soil functions and services in urban and spatial planning.		X	X	Ittner and Naumann, 2022a
135	Focus on Long-Term Monitoring of CoC Effects and Risks	Assess the long- and short-term effects of chemicals of concern on soil and human health, ensuring long-term observations are conducted at consistent sites.		X	X	Ittner and Naumann, 2022a
136	Enhance Regulatory Safety Assessments for Pesticides	Integrate assessments of the impacts of chemicals on soil and human health into regulatory safety evaluations, particularly for pesticides.		X		Ittner and Naumann, 2022a
137	Evaluate Risks and Opportunities in Material Reuse	Identify and assess the risks and potentials of reusing materials in the context of a circular economy.		X	X	Ittner and Naumann, 2022a
138	Utilise Machine Learning for Predictive Analysis	Develop methodologies to leverage machine learning for predicting pollutant risks.		X		Ittner and Naumann, 2022a
139	Focus on Contamination Prevention and Restoration	Develop legal, financial, and awareness-raising strategies for preventing contamination and restoring contaminated sites and brownfields.	X		X	Ittner and Naumann, 2022a
140	Prioritise Contaminated Site Management	Create a prioritisation method and incentives for funding mechanisms focused on contaminated sites and brownfields in Europe.	X	X	X	Ittner and Naumann, 2022a
141	Integrate Socio-Economic and Biophysical Research	Combine socio-economic research with biophysical studies to improve the understanding and implementation of prevention measures using nature-based solutions.	X			Ittner and Naumann, 2022a

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142	Support Innovations Within Living Labs	Identify and support key actions and innovations in living labs, testing and adapting practices for sustainable soil management.		X		Ittner and Naumann, 2022a
143	Address Irreversibility in Soil Management	Determine the safe operational thresholds for biomass, timber, and food production to avoid points of no return.		X		Ittner and Naumann, 2022a
144	Develop Risk Analysis and Management Tools for Policy Guidance	Apply risk analysis tools related to various environmental management issues to guide policies in response to changing climate conditions.			X	Keesstra et al. 2021
145	Conduct Resilience Studies of Soil-Plant Systems	Evaluate how climate change impacts the resilience of soil-plant systems, promoting healthy and biodiverse soils.	X			Keesstra et al. 2021
146	Foster Interdisciplinary Connections	Connect with other fields to integrate and mainstream climate change adaptation into existing workflows.	X			Keesstra et al. 2021
147	Promote Knowledge Transfer from Warmer Climate Regions	Facilitate knowledge transfer by learning from countries in warmer climate zones to identify adaptation strategies for local conditions.	X			Keesstra et al. 2021
148	Develop a Comprehensive Understanding of Soil Properties	Increase understanding of soil functioning and resilience, along with the contributions of soils to ecosystem services across various conditions.	X	X		Keesstra et al. 2021
149	Utilise Scenario Techniques to Foster Circular Bio-Economy	Develop region-specific scenarios that integrate healthy soils and landscapes to support the establishment of a circular bioeconomy.			X	Keesstra et al. 2021
150	Collaborate with Horizon Europe Mission on Soil Health and Food Systems	Seek synergies with the Horizon Europe Mission to innovate relationships between diets, land-use practices, ecosystem services, and soil health.	X			Keesstra et al. 2021

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151	Assess Current Co-Innovation Process Effectiveness	Conduct a stocktaking of current experiences related to knowledge transfer and co-innovation processes in European countries to derive valuable lessons.	X	X		Keesstra et al. 2021
152	Implement a Short Value Chain Approach	Create a short value chain that promotes sustainability by carefully considering product choices and quantities.			X	Bayer et al. 2023
153	Strengthen Urban-Rural Linkages	Reconnect urban-rural linkages, particularly emphasising their relevance in areas like Brandenburg, where Berlin is central.	X		X	Bayer et al. 2023
154	Explore Diverse Sustainable Land Management Strategies	Investigate diverse strategies, including cover crops and crop rotations, to promote sustainable land management.			X	Bayer et al. 2023
155	Assess the Potential of Organic Residues from Biogas Facilities	Evaluate the potential for organic residues from biogas facilities to be more easily transportable than manure, creating new opportunities.		X		Bayer et al. 2023
156	Collaborate with Farmers and Communities for Streamlined Approaches	Work with farmers and local communities to develop measures for conserving and improving peatlands, emphasising effective communication and realistic approaches.	X			Bayer et al. 2023
157	Promote the Advantages of Year-Round Soil Cover	Incentivise the implementation of year-round soil cover practices through financial assistance or legislative measures.			X	Garré, 2022