EUROPEAN UNION

EUROPEAN MISSION SOIL WEEK

Event report

21-23 November 2023

Research and Innovation

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CONTENTS

01

Executive summary

Executive summary

The **European Mission Soil Week (EMSW)** is an **annual event organised by the European Commission Directorate-General for Agriculture and Rural Development in collaboration with the Joint Research Centre. The first edition was organised together with the EU-funded project Preparing for the 'Soil Deal for Europe' Mission (PREPSOIL).** The EMSW 2023 united a diverse spectrum of stakeholders, **researchers, farmers, foresters, spatial planners, policymakers, and the general public**, providing a dynamic platform to delve into the forefront of **soil health research and innovation, and address key challenges**. These challenges span innovative sustainable soil management, conservation techniques, remediation strategies, and the evolving landscape of soil-related regulations, all intricately intertwined with the Commission's proposal for a Directive on Soil Monitoring and Resilience published in July 2023. Against the backdrop of the directive's recent proposal, **this year's EMSW, hosted by the National Institute of Agricultural and Food Research and Technology and Spanish National Research Council (INIA-CSIC) under the Spanish Presidency of the Council of the European Union (EU)**, held exceptional significance. Held in Madrid between **21 and 23 November 2023**, the hybrid event brought participants together to network, explore Mission-funded projects, and engage in pivotal discussions on the future of our soils. It hosted **92 speakers in more than 20 different sessions and gathered over 300 in-person participants and 600 online participants**. This report encapsulates the essence of the EMSW 2023, highlighting its key conclusions and takeaways.

Day 1 started with a keynote speech by Bridget Emmett, Head of Soils and Land Use at the United Kingdom's (UK) Centre for Ecology and Hydrology, who emphasised the critical importance of soil health in delivering essential ecosystem services, considering the growing demand for space to support nature, food security, and bioenergy. The presentation highlighted significant challenges, such as millions of potentially contaminated sites in Europe, residual pesticides affecting 83 % of EU soils, and carbon loss from cropland and drained peatlands. In her keynote speech, Emmett pointed out that **a substantial percentage of EU soils were unhealthy**, emphasising the need for monitoring, especially given regional variations in threats. The speech underscored the decline in soil organic carbon and showcased successful examples, like the UK's achievements in carbon density increase and reduced acid rain emissions. **Technology, including satellite data and advanced tools**, was lauded for monitoring, but standardisation was stressed for consistency. The importance of Living Labs, cooperation, and enhanced soil literacy resonated, with an emphasis on collective action.

Participants also had the chance to learn about the strategic implementation of the Mission Soil. In her presentation, Kerstin Rosenow, Head of the Mission Secretariat, focused on the importance of **time and capacity building for impactful soil health Living Labs**. **The collaborative 'trinity' involving policy, observation, and research** was stressed for on-the-ground impact, especially with the proposed Directive on Soil Monitoring and Resilience. The Mission Soil, integral to 12 Green Deal strategies, demonstrated progress with over EUR 300 million invested, focusing on research, Living Labs, soil monitoring, soil literacy and citizen engagement. The Head of the Mission Secretariat also called for further collaboration with the private sector, inviting other funders, such as philanthropic organisations, to explore together avenues of cooperation.

The presentation was followed by testimonies from land managers across Europe. A regenerative organic farmer from Spain shared **successful practices in sustainable agriculture**, showcasing increased biodiversity and the potential for scalability. The project manager of Future Forest, an EU pilot project on the adaptation of forests to climate change, addressed challenges in **sustainable forest management** with a focus on healthy soils, tools for

forest owners, and a reward system. And lastly, a manager of projects on urban soil from France presented an **innovative initiative to restore and reuse polluted urban soils for agriculture**, challenging traditional frameworks.

Day 1 included three lively breakout sessions.

- **Soil health for climate**: the objective of the session was to discuss synergies and trade-offs, identifying policy options for future EU carbon farming schemes. Participants emphasised synergies like biodiversity and climate adaptation, expressing a preference for a **practice-based approach in current carbon farming schemes**.
- **Soil health for food**: emphasising the link between healthy soil and food production, the discussion aimed to extend to the potential of waste valorisation as a key element in achieving a fair, healthy and environmentally friendly food system. The participants advocated for robust policy measures as another cornerstone, stressing the need for **regulations that not only encourage but actively incentivise sustainable farming practices**.
- **Farming practices for soil health**: this session explored the contribution of farming practices to maintaining, improving or re-establishing soil health, while triggering the provision of other ecosystem services. Among other conclusions, the session highlighted how **adopting soil health as a guiding principle in farming** involves assessing farming practice outputs and establishing robust monitoring systems, integrating soil monitoring and data collection.

In a session focusing on the **Mission's international dimension**, Kerstin Rosenow started by underscoring the global importance of soil health, highlighting its role in carbon sequestration and greenhouse gas reduction. She pointed out that the **Mission Soil aligns with existing EU commitments**, emphasising international cooperation through initiatives like the **UN Convention to Combat Desertification** and participation in global forums such as the **United Nations Climate Change Conference COP28**. Operational objectives include promoting European soil carbon research internationally and enhancing monitoring capabilities through collaboration. Jean-François Soussana, Vice-Chair for international affairs at the French National Institute for Agriculture, Food and Environment, outlined the **roadmap towards the Soil Carbon International Research Consortium** (IRC), highlighting the Coordination of International Research Cooperation on Soil Carbon Sequestration in Agriculture (**CIRCASA**) project and its successor, Operationalising the International Research Consortium on Soil Carbon (**ORCaSa**), and the need for governance and collaboration agreements. Suzanne Reynders presented the governance structure, emphasising the IRC's inclusive approach to membership and the establishment of committees to guide its focus. The Soil Carbon IRC team's services include **research collaboration, the Impact for Soil platform, harmonising monitoring, reporting and verification frameworks, and engagement with the international community**. Christian Holzleitner, Directorate-General for Climate Action, highlighted the EU's climate objectives and invited **support for developing European standards for carbon farming**. Jean-François Soussana concluded by emphasising the importance of **collective European efforts through the Soil Carbon IRC**.

The day finished with an **award ceremony for the winners of the Mission Soil photo competition**.

Day 2 opened with a keynote speech on the urgent need for a **comprehensive approach to restore European soils**, encompassing social, cultural, and economic dimensions. Anna Krzywoszynska, Mission Board Member, underscored the far-reaching impact of human society on Earth's various systems and illustrated these effects through powerful visual representations. Emphasising the Critical Zone concept and its relevance to soil health, the

keynote stressed the importance of **justice considerations in environmental policies**. The need for foundational work to understand how different aspects of social life affect soils was underscored, encouraging improvements in existing practices like crop diversification and waste management. Krzywoszynska advocated for **transformative changes at institutional, cultural, economic, and political levels,** emphasising a **co-production process for sustainable transformations**. The importance of transdisciplinary approaches in the Mission Soil initiative was highlighted, along with the role of the arts as a form of research offering fresh perspectives on soil health and sustainability.

This was followed by several presentations on the Mission-funded project PREPSOIL and how it supports the Mission Soil. Spanning from 2022 to 2025, the project involves a consortium of 20 partners from various EU Member States and Norway. Emphasising a broad audience, including farmers and NGOs, Line Friis Lindner pointed out **PREPSOIL's goal of connecting stakeholders to enhance soil literacy and awareness** through tools and spaces for interaction. In another part of the presentation Saskia Keesstra discussed the regional approach of assessing soil needs across diverse EU regions, emphasising the socio-economic and geo-biophysical perspectives. The assessment involved workshops, interviews, and the creation of posters detailing regional soil needs, offering valuable insights into the challenges faced by different areas. Lindner underscored the **implications of PREPSOIL, particularly its role in Living Labs, monitoring, and science–policy interactions**, encouraging participants to explore the project's resources on their website for more information.

During the Mission Soil's regional and local dimension session, participants gained insights into various projects fostering soil health awareness and engagement. The presentation commenced with accomplishments of the Mission-funded project Healthy Municipal Soils (HuMUS), including **policy brief-like deliverables and a forthcoming training programme** to build the capacity of Soil Stewards who facilitate regional and municipal dialogues on soil health. They initiated a call for pilot projects to involve local communities and inspire broader European adaptations. The City of Madrid shared their project connecting green areas to enhance biodiversity, underlining **the importance of citizen involvement in urban land planning and of campaigns in schools** for the wider public awareness. The session also presented Leeuwarden's endeavours in banning herbicides, as well as in soil analysis and urban planning tools, emphasising citizen engagement through campaigns. The speakers collectively stressed the **prevailing lack of citizen awareness on soil health** and discussed the potential for change through educational initiatives and increased prioritisation of soil health in regional and local planning.

Participants also had the chance to learn about the Mission Soil Manifesto and hear from a few of its signatories. The presentation outlined the diverse entities supporting the Manifesto, including cities and private sectors, and stressed the need for increased visibility, especially among municipalities. The signatories underscored the challenges faced in their respective areas and tangible initiatives to combat soil issues, **urging governments to support the Manifesto**. The testimonials highlighted the **urgent call for collective action** and the shared responsibility for building a sustainable future. The subsequent discussion with the newly appointed Mission Soil Ambassadors revealed the Ambassadors' commitment to and creativity in spreading awareness about soil health. They pointed out the importance of engaging various audiences, from children to scientists, and highlighted practical initiatives, such as using earthworms for improving soil health or collaboration with schools on the ground, showcasing the multi-stakeholder approach of the Mission Soil. The testimonials emphasised the **crucial link between healthy soil and healthy food**, reinforcing the Ambassadors' dedication to promoting soil health as an honourable responsibility.

Day 2 included five lively breakout sessions:

- **Soil needs in PREPSOIL regions: engaging with multiple actors**: this session was organised by the PREPSOIL project and its objective was to inform the audience about the soil needs assessments performed by the project in regions covered by different land uses and to collect feedback from the audience for soil needs in other similar regions. The session highlighted numerous challenges and proposed **solutions specific to certain land uses: urban, forestry, agricultural, and mixed-land use**.
- **Knowledge transfer to farmers' advisers**: the session covered several topics, including approaches to transferring knowledge to farm advisers and addressing challenges of dissemination activities. Participants discussed how the **Mission Soil could improve knowledge transfer to farm advisers**, focusing on refining the structure and approach of projects for practical impact.
- **Living Labs and other experiences from placed-based innovation**: this session included discussions on the Living Labs concept, detailing how the Mission Soil uses Living Labs to address soil health challenges and updates on their current implementation status under the Mission. Participants emphasised the need to **integrate human values in land use**, suggesting a shift towards a more inclusive and participatory economic model that underscores networking and sharing practices.
- **Soil biodiversity**: the session sought to highlight the significance of soil biodiversity for global food security, the Sustainable Development Goals (SDGs), and human health. Speakers stressed the need to **consider both taxonomic and functional diversity, align conservation practices with agriculture, and ensure economic viability**.
- **Business models for soil health**: the session aimed to shed light on the multi-faceted business cases for investing in soil health across different land uses. The importance of **collaboration and sustainable business models, valuing ecosystem services in financial terms, and integrating soil health into core business strategies** were key themes.

Day 3 started with a presentation on the developments and achievements of the EU Soil Observatory (EUSO). Arwyn Jones and Panos Panagos from the Joint Research Centre, European Commission, emphasised EUSO's crucial role in **supporting soil policy through EU-wide monitoring, a robust European Soil Data Centre (ESDAC), and active collaboration with stakeholders**. The presentation highlighted key accomplishments such as the EUSO Annual Bulletin and the informative EUSO dashboard, offering insights into soil degradation across the EU. Notably, **EUSO played a pivotal role in contributing to various EU initiatives**, including the Mission Soil, the Nature Restoration Law, and the Clean Soil Outlook. The speaker also discussed research and innovation (R&I) efforts, citizen engagement initiatives, and outlined future plans, including the release of the EU Land use and land cover survey (LUCAS, with nearly 20 000 topsoil samples) version 2 and assessments on EU Biodiversity and Antimicrobial resistance.

In the following session on assessing soil health at different scales, participants learned about the importance of **tailoring soil-related initiatives to regional contexts** and the significance of downscaled vulnerability assessments. In another presentation, Rachel Creamer, Coordinator of the Mission-funded project BENCHMARKS, emphasised the evolution of soil health indicators**, advocating for a holistic approach and harmonised data collection** to support the recently proposed Soil Monitoring Law. The BENCHMARKS project focuses on starting at the local level, engaging stakeholders to define meaningful indicators that drive soil change. Additionally, participants learned about the Mission-funded AI4SoilHealth, a project using artificial intelligence to accelerate soil

health data collection and to provide tools that will, for example, help farmers to improve efficiency of fertiliser use. AI4SoilHealth uses **innovative proxies, including water repellence and tree diseases, for facilitating practical, cost-efficient soil health monitoring**.

The following panel discussion provided insights into various crucial aspects of soil monitoring and indicators. The panellists pointed out the challenges faced by farmers, including knowledge gaps in biological health indicators and issues related to soil analysis availability and timeliness. Emphasis was placed on the **significance of local-scale approaches in effective soil management practices**, with examples from Austria's agro-environmental units. The importance of obtaining **comprehensive data at the local level for continental-level assessments** was underscored, stressing the need for clear indicators and reliable data for informed policymaking. Insights into New Zealand's soil health approach and the challenges of setting up monitoring systems due to limited access to privately owned lands were shared. The discussion also covered the challenges and importance of implementing a European-scale monitoring programme, with a focus on on-field data collection and machine learning approaches. The panellists stressed the **need for simplicity in core indicators, the enduring success of long-standing monitoring programmes, and the importance of engaging family farms through Living Labs**. Additionally, the panel highlighted the approach to studying soil biodiversity, the need for representative ecosystem variations, and the efforts to engage stakeholders and address economic aspects at different scales.

The last session of the conference touched on the outcomes of the EUSO Working Groups, each addressing specific aspects crucial for soil health. The presentations highlighted the diverse focus areas, starting with soil biodiversity, where the group conducted the first assessment of European soil biodiversity, resulting in publications on bacteria, fungi and eukaryotes. The soil erosion group emphasised progress in trend indicators and addressing gaps in knowledge, **estimating annual erosion costs between EUR 16.5 billion and EUR 68.8 billion**. The soil pollution group contributed to the Zero Pollution Monitoring and Outlook Report, discussing indicators, the polluter-pays principle, and the international dimension of soil pollution. The soil data sharing and integration group explored data management across projects, underscoring the dual nature of data and discussions on delivery timeframes. The carbon group focused on coordinating research activities, supporting monitoring, reporting and verification (MRV) initiatives, and collaborating with projects like ORCaSa. The soil monitoring group delved into citizen science initiatives, acknowledging their value, and discussed challenges related to biases, privacy, and sustainability. The working groups aim for **integrated processes involving the broader scientific community and Mission Soil projects,** contributing to the advancement of soil science and policy development.

The closing ceremony highlighted three key messages from the event. Firstly, the positive response to **bringing farmers, foresters, and urban communities together**, focusing on collaborative solutions. Secondly, the enthusiasm in the room and the need to **sustain momentum** and assess progress next year. And thirdly, the **importance of driving the Living Labs and Lighthouses approach forward**, aiming for real impact on the field through the ongoing dialogue initiated during the conference.

More information, including presentations and recordings of plenaries, are available on the Mission Soil website.[1]

[1] https://mission-soil-platform.ec.europa.eu/news-events/european-mission-soil-week-2023

Plenary sessions

Day 1: Plenary sessions

1. Opening session

Francisco Javier Moreno Fuentes, Vice-President for International Affairs at CSIC, welcomed attendees, emphasising the **pivotal role of soil research in addressing societal challenges and facilitating the green transition**. He provided an overview of the CSIC, the largest research organisation in Spain, comprising over 120 institutes in the areas of matter, life, and society. Moreno Fuentes cautioned attendees that while science can offer empirical evidence and solutions, the **political and social implications of soil policies involve complex negotiations** and may not always align with scientists' preferences. Moreno Fuentes outlined **CSIC's pragmatic approaches**, including interdisciplinary collaboration, policy synthesis through the Science for Policy initiative, Cicero Itineraries fostering mutual learning, and COCREA Labs aligning research interests. He expressed optimism that the conference would foster collaboration and address societal challenges collectively.

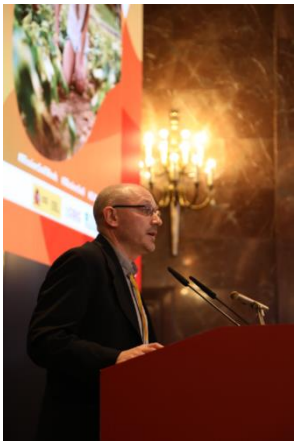

Figure 1. Francisco Javier Moreno Fuentes during the opening session

'There is no question that soil research is a key aspect for all our activities related to the green transition and to many pressing societal challenges.' – Francisco Javier Moreno Fuentes

Figure 2. Maciej Golubiewski during the opening session

Maciej Golubiewski, Head of Cabinet Wojciechowski, Commissioner for Agriculture, opened the session thanking the Spanish Presidency for hosting the event and acknowledging its commitment to soil health restoration, which is crucial for the Green Deal objectives. He stressed the urgency to address soil health to **make our agriculture and food systems more resilient to climate change**. Golubiewski recalled the EU strategy for healthy soils by 2050, setting out the legislative framework and, through the Mission Soil, the means for soil health monitoring and the necessary knowledge and innovation to enable the transition. Golubiewski detailed the Mission Soil's objectives, progress, and synergies with the Common Agricultural Policy (CAP).

'The EU Missions are not just about science, innovation and technology. They are also about people. In the context of soil, we want to involve citizens to increase soil literacy.' – Maciej Golubiewski

José Antonio Sobrino, Deputy Director General at the Ministry of Agriculture and Food of Spain, emphasised the crucial **role of agricultural soils in global food security** and the need for effective soil management practices. José Antonio Sobrino outlined Spain's national initiatives, including a royal decree on sustainable nutrition, collaboration with INIA-CSIC, and monitoring the impact of CAP measures on carbon stock. He stressed the importance of **research, collaboration, and communication** in understanding and conserving soil health. Sobrino commended the EMSW 2023 as an exemplary initiative.

Figure 3. José Antonio Sobrino during the opening session

'It's important to explain to society the role of soil in their own food supply and that of future generations, raising awareness of the importance of soil conservation. in all this, the European Mission Soil Week is an initiative that can serve as an example.' – José Antonio Sobrino

Figure 4. Raquel Yotti during the opening

Raquel Yotti, Secretary General for Research at the Ministry of Science and Innovation of Spain, linked Spain's global priorities to the Mission Soil conference themes. She emphasised the **transformative potential of R&I investments**, particularly in agriculture, and highlighted Spain's involvement in EU Missions. Yotti underscored the crucial role of soil in providing essential services, aligning with the Mission Soil's objectives. She called for **increased science community involvement** in Mission Soil initiatives, showcasing Spain's progress in the CAP strategic plan, soil mapping, literacy communication, and Living Labs and Lighthouses development. Yotti concluded by highlighting the Mission Soil's catalytic role in the publication and approval of the Spanish CAP strategic plan 2023–2027, demonstrating the **transformative potential of science, innovation, and sectoral policies** to confront global challenges.

'It is very clear that soil plays a pivotal role in providing essential services for both people and environment. And it is indispensable for sustaining our daily food needs, refining water sources, mitigating flooding risk and combating draughts.' – Raquel Yotti

2. Keynote speech: Setting the scene for the Mission Soil

The status of soils in Europe by Bridget Emmett, Head of Soils and Land Use at the UK Centre for Ecology and Hydrology

'It takes 100 years to build half a centimetre of soil on average. Yet, construction companies find it easier to just dig out uncontaminated soil and take it to landfill sites. We're throwing hundreds and thousands of years of nature's work away. We absolutely have to reuse and recycle and turn that statistic around.' – Bridget Emmett

Bridget Emmett started her presentation by **stating that healthy soil has the continued capacity to deliver essential ecosystem services**. The increasing demand for space to support nature, food security and bioenergy, coupled with the rising competition for land and soil, underscores the need to ensure soil health to maintain these crucial services.

Figure 5. Bridget Emmet presenting the session 'The status of soils in Europe'

Highlighting the problems, Emmett pointed out that **2.8 million potentially contaminated sites exist in Europe**, with only 24 % inventoried and 65 500 remediated. EU soils face issues such as residual pesticides (83 % of EU soils), cadmium concentrations in agricultural soils exceeding drinking water limits (21 %), and heavy metal content potentially unsafe for food production (6 %). Cropland soils are losing carbon at a rate of 0.5 % annually, and 50 % of peatlands are drained, contributing to carbon loss. She emphasised the slow rate of soil formation, taking 100 years to build half a centimetre, and the alarming trend of disposing uncontaminated soil in landfills, highlighting the need for reusing and recycling.

Referring to the document 'Caring for soil is caring for life',[2] Emmett shared insights from the Soil Health and Food Mission Board (the name of the first Mission Soil Board), which concluded that **60 to 70 % of EU soils were unhealthy across various land use types**. Monitoring has been identified as crucial, with variations in threats across regions, such as peatland degradation in northern Europe and water erosion in southern Europe.

Emphasising the importance of **soil organic carbon**, Emmett noted a **0.75 % loss between 2009 and 2018**. The UK's success in carbon density increase through reduced tillage and inorganic fertilisers served as a positive example. She also highlighted the UK's achievements in reducing acid rain emissions, resulting in soil recovery and improved water quality.

Technology, including the Copernicus Sentinel that provides satellite data, was lauded for its **role in monitoring soil erosion**. However, Emmett stressed the need for standardisation to track changes consistently over time. Advanced technologies like eDNA, sensors, artificial intelligence (AI), and next-generation soil process models are being employed for novel indicators and management solutions. Emmet acknowledged the value of this technology, but for the sake of consistency and efficiency, she called for caution and consistency when it comes to monitoring tools.

To address soil health, Emmett called for **Living Labs, cooperation, time-bound targets and monitoring outcomes**, **enhanced soil literacy, and new R&I**. She emphasised that collective action is necessary, involving not only the European Commission and farmers but everyone. Collaborating with the media, she shared her experience working with the BBC to create an animation film promoting soil awareness. Emmett concluded by advocating for a shared responsibility in handing down better, safe, stable, and healthy soil to future generations.

In response to a question about **reaching out to farmers**, Bridget Emmett emphasised the importance of soil monitoring at both national and individual levels. While national-scale monitoring is essential for reporting, Emmett acknowledged that farmers need tools for individual monitoring to make real-time adaptations. Collaborating with farmers, her team provides simple methods and benchmarks, empowering farmers to collect data themselves and make informed decisions.

Regarding a question on **policy instruments** like result-based payments, Emmett expressed the need for a gradual approach. In the UK, they currently pay farmers for measuring their soil, a crucial step in building farmer confidence in monitoring. Emmett suggested that, in the future, outcome-based payments could be considered, but she emphasised the importance of proceeding gradually to avoid overwhelming farmers and to achieve the ultimate goal of outcome-based payments.

[2] https://research-and-innovation.ec.europa.eu/knowledge-publications-tools-and-data/publications/all-publications/caring-soil-caring-life_en

3. The Mission Soil in a nutshell

Policy context and main Mission Soil achievements by Kerstin Rosenow, Head of the Mission Soil Secretariat

'Launching soil health Living Labs takes time and capacity building, but the idea is to have true impact on the ground. This is not an easy process, which is why we need all of you here.' – Kerstin Rosenow

Kerstin Rosenow started by highlighting the **Mission's unique instrument**. It was conceived not as another European research project but as a concerted effort to address a pressing societal challenge and have a concrete impact on EU citizens. The idea was to elevate the issue to the forefront of research policy, agricultural agendas, and civil society discussions at the European level and to pull all possible actions together to achieve a common goal.

Figure 6. Kerstin Rosenow presenting the session 'Policy context and main Mission Soil achievements'

Rosenow emphasised that soil is not a niche concern but the very foundation of life itself. The **collective engagement of the community**, as evidenced by the gathering of attendees at the Mission Soil conference, was seen as a pivotal factor in making a tangible difference in addressing soil-related challenges.

The Mission Soil is embedded in **12 Green Deal strategies, communications and action plans**, highlighting its significant contribution to meeting targets and objectives. This political recognition provides legitimacy for further actions and initiatives.

Addressing the absence of a policy framework for soil management at the Mission's inception, Rosenow stressed the importance of a **collaborative 'trinity' involving policy, observation, and research**. This collaboration aims to foster co-creation, innovation, and on-the-ground impact.

The proposed Directive on Soil Monitoring and Resilience is viewed as a crucial instrument, with shared objectives of leading the transition to healthy soils, developing a **harmonised monitoring framework**, and **enhancing awareness of soil importance**. The Mission aligns closely with these objectives and actively contributes to the directive's implementation.

Several actions are underway to harmonise the monitoring framework, including work on **transfer functions**, **interlaboratory calibration**, understanding **soil health indicators**, and identifying **practices that regenerate healthy soil conditions**. Rosenow highlighted these areas as focal points for ongoing and future collaboration.

The Mission's scope extends to all types of soils and lands, covering urban, forest and agricultural areas. The **four primary action areas called 'building blocks'** – R&I programme; Living Labs and Lighthouses; soil monitoring; and soil literacy, communication and citizen engagement – demonstrate a comprehensive approach to addressing soil challenges.

The Mission Soil, with its focus on empowering Living Labs, aims to accelerate and scale up the adoption of sustainable soil management solutions. Rosenow emphasised **Living Labs as a unique approach**, involving collaboration with individuals on the ground, such as farmers and foresters, to generate locally adapted solutions. She added that **Lighthouses serve as demonstration sites** for showcasing successful practices, providing training and facilitating communication.

Rosenow provided insights into the Mission's progress through consecutive **Work Programmes, with over EUR 300 million already invested**. The Work Programme 2021 is yielding positive results. The Work Programme 2022 includes initiatives to build up a Living Labs support structure and monitor different indicators, and the Work Programme 2023 saw the launch of the Living Lab call, garnering a high number of applications.

In conclusion, Rosenow reported on the **positive results of the assessment of two-year progress of the EU Missions**, which demonstrated that the Mission Soil is on track to meet its 2030 ambition towards a rapid green transition. To move forward, the Mission Soil, together with the other EU Missions, has taken steps to: improve its governance; boost co-investment beyond Horizon Europe, including by inviting the private sector and philanthropic organisations to support and collaborate with the Mission (an invitation that was publicly and openly extended once again during the session); enhance synergies with other EU instruments; and improve the communication efforts and outreach to stakeholders and citizens.

3.1 Testimonies from land managers

In the next session, three land managers from different European regions, shared practical examples of how they addressed their specific regional challenges.

Yanniek Marijn Schoonhoven, regenerative organic farmer and co-founder of the Regeneration Academy, La Junquera farm and village, manages a 1 100 hectare farm in a challenging semi-arid area between Andalusia and Murcia. Facing **extreme weather conditions** with minimal rainfall, she highlighted the region's **depopulation** due to difficulties in sustaining agriculture.

Their farm serves as a **hub for regenerative and sustainable projects** in education, research, entrepreneurship, and ecosystem restoration. Over 20 crops are cultivated, with a significant increase in organic matter by 1 %. The

farm also operates as the Regeneration Academy, hosting students, professionals and researchers to promote regenerative practices and sustainable agriculture.

Through events and collaborations, they **engage with local farmers**, fostering knowledge exchange. The farm implements regenerative practices like creating ponds for improved water uptake, planting hedges and trees for increased biodiversity, and avoiding soil tillage. Facing challenges with cultivating pistachio trees, they found solutions like vegetation strips to prevent erosion without harming yields. As a result, they have witnessed 30 % more biodiversity in the area.

After 14 years of successful practices, Schoonhoven and her team aim to scale up, converting farms in an additional 1 000 hectares into organic and regenerative farms. Their broader goal is to restore the valley, making water drinkable and revitalising the community. The farm serves as a **model for sustainable agriculture**, proving that regenerative practices can be both environmentally friendly and economically viable.

Theresa Luber, Project Manager at blue!, shared insights into the LIFE project Future Forest during her presentation. The project, based in Landsberg, Germany, focuses on **sustainable forest management**, particularly emphasising healthy and living soils.

The nearly four-year project addresses the challenges posed by climate change, such as reduced **water availability in forests**, especially affecting spruce trees with shallow root systems. Recognising the importance of healthy soils, the project concentrates on humus forms, fine roots, and earthworms. To enhance soil quality, they aim to transition from spruce monocultures to predominantly deciduous mixed forests with increased biodiversity.

To facilitate wider acceptance and implementation of sustainable forest management, **the project developed three tools**. The self-assessment tool allows forest owners to evaluate their forest's overall health, considering factors like tree species and cultivation methods. The Future Forest Handbook, currently in development, offers practical guidance for municipalities and forest owners on managing forests with a soil-focused approach. Expected to be published in early 2024, the handbook aims to serve as a practical guide for those involved in forest management, encouraging positive changes in forest practices. The project also introduced a valorisation system, emphasising ecosystem services beyond just CO_2 sequestration. Forest owners are financially rewarded based on their forest's level, ranging from EUR 100 to 400 per hectare per year. This funding comes from companies and municipalities, aiming to motivate and reward forest owners for sustainable practices.

Summing up, Luber concluded that the overarching goals of the project include **generating motivation and rewards for forest owners**, promoting sustainable forest management and fostering societal appreciation for the valuable services provided by forests.

Jamila Bentrar, Manager of projects on urban soils requalification at European Metropole of Lille, presented an initiative addressing the challenge of **polluted urban soils** in the European Metropole of Lille. With 1.2 million inhabitants and a EUR 2 billion yearly budget, Lille Metropole faces soil pollution issues, particularly due to its industrial past.

Despite the polluted urban soils, the European Metropole of Lille is determined to develop **urban agriculture projects**. Facing difficulties in finding healthy soils for these projects, the metropole has launched a research action programme. This collaborative effort involves laboratories, private companies, start-ups, non-governmental

organisations (NGOs), and public authorities. The programme aims to identify available resources, including mineral, chemical, and organic materials, to create and test various soil compositions.

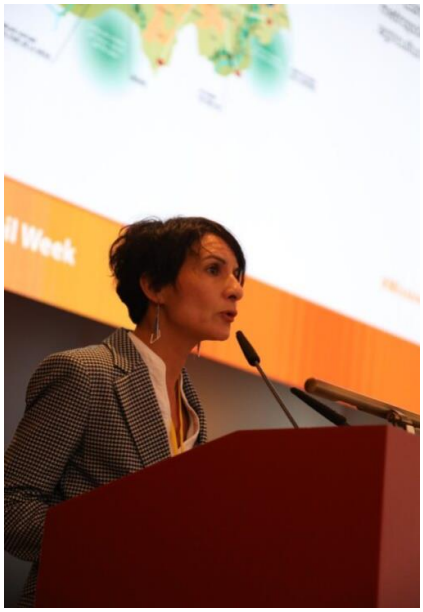

Figure 7. Jamila Bentrar presenting in the session 'Testimonies from land managers'

'Thanks to this new recipe we're going to restore soils and create a new function of soils. Instead of exploiting resources and creating scarcity, we create resources and generate abundance.' – Jamila Bentrar

The two-year research programme focuses on **monitoring the restoration of soil functions**, such as fertility, water storage, carbon sequestration, and support for biodiversity. By reusing only healthy materials, the goal is to expedite the implementation of agricultural projects for food production.

Beyond local impact, Lille Metropole envisions **sharing inspiring solutions with other communities**. The initiative challenges the existing legal framework, which traditionally focuses on managing the negative environmental impacts of urban projects. Instead, they propose a **shift from impact management to resource management**, aiming to preserve and valorise healthy materials on site.

The innovative approach seeks European partners to **join a consortium and become Living Labs**, embracing a paradigm shift towards creating new resources for economic development rather than exploiting existing ones. The European Metropole of Lille invites interested partners to collaborate in this transformative initiative.

During the **question-and-answer session** that followed several insightful discussions emerged.

The first question was about the **challenges the speakers are facing in changing soil quality**. Yanniek Marijn Schoonhoven highlighted the scarcity of organic fertilisers in their region, leading to a lack of compost. Extreme climate conditions make composting challenging due to the limited availability of green material. Theresa Luber emphasised the neglect of soil in forest management, particularly the need to adapt forests to new conditions rather than revert to historical states. Forest owners face challenges in prioritising financially lucrative spruce logs over deciduous trees.

Regarding a question on the **payments for forest owners**, Theresa Luber explained that compensation figures aimed to bridge the income loss incurred by not selling spruce logs (since deciduous trees cannot be sold to timber companies).

Jamila Bentrar identified two key challenges – time constraints in policy creation for urban agriculture and a lack of a legal framework for innovative approaches. Theresa Luber discussed regulatory issues as well, indicating that local communities were hesitant to contribute funds without a CO_2 certification system. She stressed the importance of society recognising the broader value of ecosystem services beyond just CO_2.

The session also delved into the **localised nature of the speakers' approaches** compared to more universal strategies pursued by R&I in universities. Yanniek Marijn Schoonhoven clarified that their place-based approach aimed to teach farmers a universal way of looking at their land and integrating potential possibilities. Jamila Bentrar highlighted that their research programme's goal was to provide a methodology rather than a local solution.

Another question addressed the potential **benefits of grazing livestock in forests for soil quality**. Theresa Luber discussed an EU-funded project focused on agroforestry, expressing the belief that combining various approaches could yield added value.

When asked about their needs from the Mission Soil, Yanniek Marijn Schoonhoven emphasised the importance of soil analysis for their large farm. Theresa Luber urged the promotion of reward systems focusing on ecosystem services, while Jamila Bentrar sought partners to collect valuable information for their research programme.

A question about **soil certification** led Yanniek Marijn Schoonhoven to highlight its potential to benefit soils on a large scale.

The final question explored **strategies for encouraging foresters and farmers** with unsustainable practices to transition to sustainable solutions. Yanniek Marijn Schoonhoven suggested demonstrating financial viability, emphasising the interconnectedness of ecosystems, and leveraging associations/initiatives for information sharing. Theresa Luber emphasised the importance of understanding the positive effects of sustainable practices, reducing risks through guidance and funding, and fostering a mindset of sustainability.

4. The Mission's international dimension

Mission Soil: the international dimension: Kerstin Rosenow, European Commission

'This is one of the Mission's specific objectives – reduce the EU global footprint on soils. We need to recognise the global impact of EU production and consumption.' – Kerstin Rosenow

Kerstin Rosenow emphasised the **global significance of soil health**, citing challenges shared among countries and regions. Soil health, crucial for carbon sequestration and reducing greenhouse gas emissions, has global consequences. In aiming to reduce the EU's global soil footprint, the Mission Soil aligns with existing EU commitments, including the UN Convention to Combat Desertification (UNCCD) and the SDGs.

Rosenow added that an essential objective is **recognising the impact of EU production and consumption** on a global scale, particularly through agricultural trade. In this context, the Joint Research Centre (JRC) is developing an **EU soil footprint calculator** by 2025. International cooperation is a priority, with efforts to connect with the Global Soil Partnership (FAO) and participation in key global discussions like the UN Framework Convention on Climate Change's COP28.

Rosenow pointed out that the European Commission's involvement in initiatives like AIM for Climate and the Global Research Alliance on Agriculture Greenhouse Gases demonstrates its **commitment to international collaboration**. Despite decreasing funding for public research in agriculture globally, the EU, through Horizon Europe, is investing heavily due to the urgency of addressing significant challenges.

Rosenow highlighted that **Africa is a key focus for inter-regional cooperation**, with data and monitoring developed by the Mission Soil potentially being replicated by African partners. The Mission also collaborates with Latin America, Caribbean countries, Canada, China and Japan, among others.

Operational objectives that are relevant in this context include **promoting European soil carbon research internationally and conserving soil organic carbon stocks**. The Mission aims to enhance monitoring capabilities and facilitate larger-scale testing of technologies/protocols through international cooperation. Other successful international research consortia, particularly in animal health, can serve as models for the IRC on soil carbon.

Rosenow pointed out that the **launch of the Soil Carbon IRC** is a strategic move to provide an improved understanding of agricultural soil carbon sequestration, synthesise stakeholder views and strengthen the international research community. The goal for this session was to spread awareness, highlight benefits for potential members, explain governance and connect with the latest developments in EU climate policy.

Roadmap towards the Soil Carbon IRC: Jean-François Soussana, Vice-Chair for international affairs at the French National Institute for Agriculture, Food and Environment (INRAE)

Jean-François Soussana outlined the **roadmap towards the Soil Carbon IRC in three steps**. The first step involved the project Coordination of International Research Cooperation on Soil Carbon Sequestration in Agriculture (CIRCASA), initiated before the Mission Soil, focusing on carbon sequestration in agricultural soils, aligning with the Paris Agreement. The successor project, Operationalising the IRC on Soil Carbon (ORCaSa), broadened CIRCASA's scope to include non-agricultural soils. The culmination of these efforts is the launch of the Soil Carbon IRC.

Jean-François Soussana pointed out that **CIRCASA had facilitated global research and knowledge exchange with partners** across continents, addressing knowledge gaps through workshops and surveys in multiple languages. The outcomes included **identifying knowledge gaps** and **formulating the Strategic Research and Innovation Agenda on agricultural soils**. Recognising MRV challenges, a concept paper proposed an integrated approach using modelling, remote sensing, and climate, soil and agricultural practices data.

Jean-François Soussana continued by giving an **overview of ORCaSa**, a Horizon Europe project running until August 2025. The project involves **research organisations and specialists globally**, including regional nodes in Latin America, the US, Vietnam, Africa, and Australia. Objectives include supporting the Paris Agreement and SDGs, raising awareness on soil carbon, benefiting international cooperation, and co-constructing harmonised MRV methodologies.

Finally, Jean-François Soussana said that the **Soil Carbon IRC's roadmap requires defining governance, improving the business model, and creating IRC services**. Collaboration agreements with other initiatives aim to avoid duplication and encourage synergies, alignment, and research co-construction.

Governance of the Soil Carbon IRC: Suzanne Reynders, INRAE

Suzanne Reynders from INRAE presented the governance structure of the Soil Carbon IRC. She pointed out that **the IRC is seeking members**, including research organisations, universities, initiatives, Living Labs, and funders, both public and private. Key partners, such as policymakers, farmers, landowners, foresters, start-ups, companies, environmental agencies, and NGOs, are essential users who will guide the IRC's focus.

The envisioned governance includes a **steering committee with action groups** dedicated to overseeing the three pillars and the IRC's business model. Representatives from researchers, funders, users, and regional nodes will be part of the steering committee.

To avoid duplicating work, **the steering committee will collaborate with the scientific committee of the 4 per 1000 Initiative**, comprising global experts. An ethics committee will also be established. An interim steering committee will be formed in Q1 2024, and the first scientific committee meeting was scheduled for December 2023, during COP28.

Suzanne Reynders pointed out that the **legal status and funding mechanisms of the Soil Carbon IRC are yet to be defined**. Research and understanding of other consortium models will inform decisions. The interim steering committee will choose the legal status and business model, based on a proposal by the ORCaSa executive board.

Services provided by the Soil Carbon IRC: Jean-François Soussana, INRAE; Julien Demenois, French Agricultural Research Centre for International Development (CIRAD); Susana Romao, Vizzuality; Fenny Van Egmond, International Soil Reference and Information Centre (ISRIC); Suzanne Reynders, INRAE; and Christian Holzleitner, Directorate-General for Climate Action (DG CLIMA)

The Soil Carbon IRC team presented a comprehensive set of services during the conference.

Jean-François Soussana started off by presenting the first service involving **research collaboration alignment through the creation of a knowledge hub**. The hub will consist of existing research projects globally, allowing them to share knowledge and data, and draft policy papers. International experts will cover key research areas to achieve common soil research objectives. Additionally, **Thematic Annual Programming** will facilitate collaboration between national research funding agencies globally. As part of the Thematic Annual Programming, funding agencies will agree to launch nationally similar research calls and add 10 % dedicated funds to facilitate international collaboration between projects.

Julien Demenois and **Susana Romao** presented **Impact for Soil, a dedicated worldwide knowledge platform**. Developed by CIRAD and Vizzuality, it addresses soil carbon sequestration challenges, catering to practitioners, farmers, policymakers, and scientists globally. The platform verifies, gathers, and shares reliable information, fostering collaboration and providing science-based evidence for decision-makers. Susana Romao highlighted the **transformative impact of Impact for Soil**. It goes beyond data and technology, aiming to empower decision-making and create a collaborative community. The platform enables users to **develop networks, explore projects, and access comprehensive analyses** and over 25 000 peer-reviewed publications. New services, such as practices and datasets, are in development.

Fenny Van Egmond, ISRIC, discussed the importance of harmonising MRV frameworks. The goal is to develop, as a community, a **harmonised MRV system that fits with the IRC's objectives**. Existing frameworks and pre-work involve MRV blocks, with building blocks within each. The ISRIC team is eager to collaborate with Mission Soil projects working in this area.

Suzanne Reynders, INRAE, highlighted the **IRC's engagement with the international community**, including workshops, world cafes, and regional events. Feedback from 35 countries shaped the IRC's governance model and

identified knowledge gaps. To join the IRC, organisations need to sign a non-legally binding letter of interest, with a stronger commitment required for steering committee participation.

The presentation featured video messages from supporters of the Soil Carbon IRC, including representatives from the **UN's Food and Agriculture Organization**, the **University of Sydney**, **Colorado State University**, the **International Centre for Tropical Agriculture**, **Michigan State University**, **InVivo**, the **4 per 1000 Initiative** and the **University of Aberdeen**. The Global Soil Partnership emphasised the importance of collaboration between the Soil Carbon IRC and policymakers.

Christian Holzleitner, Directorate-General for Climate Action (DG CLIMA), recalled the EU's objective to achieve climate neutrality by 2050. He highlighted that **agriculture and forestry play key roles, with soil carbon sequestration being a crucial aspect**. Holzleitner added that MRV is the initial step, and the **EU's proposed regulatory framework** will enable certification of various carbon removal methods, including nature-based solutions, technology, and long-lasting products. Holzleitner invited participants to **support the DG CLIMA Expert Group on Carbon Removals** to help develop European standards for carbon farming. Finally, Holzleitner invited everyone to the **European Carbon Farming Summit, organised by the Mission-funded CREDIBLE project**. The event will take place in Valencia, Spain, between 5 and 7 March 2024, and will make it possible to coordinate efforts to move methodologies forward.

Figure 8. Christian Holzleitner presenting at the session on the Mission's international dimension

'We must empower our farmers and foresters to take control of the greenhouse gas emissions and remove them. Thankfully, we have all the digital solutions and AI to provide this at low cost. To us, MRV is the first step to get this transition going.' – Christian Holzleitner

Jean-François Soussana concluded by emphasising the importance of **collective European efforts through the Soil Carbon IRC**. He added that the IRC is aiming for a cooperative and workable framework that is especially beneficial for small farmers. He stressed that Europe's cooperative approach should be an **inclusive and collaborative effort for a sustainable impact worldwide**.

5. Mission Soil photo competition award ceremony

Present at the Mission Soil photo competition award ceremony were Diego Canga Fano, Director of Quality Policy, Research & Innovation, Outreach at the Directorate-General for Agriculture and Rural Development (DG AGRI), and Carmen Vela Olmo, Director of Collaborative Projects at Gold Standard Diagnostics.

Diego Canga Fano explained that the **competition aimed to increase awareness of soil importance and beauty**, a crucial step in promoting sustainable land management practices. The initiative, aligned with one of the Mission Soil's objectives on **enhancing soil literacy and citizen engagement**, engaged both professional and amateur photographers.

Carmen Vela Olmo highlighted the unique aspect of citizen engagement in the Mission Soil and emphasised the **synergy between art and science**. She expressed that both fields share a common ground, breaking down walls, working with passion, enthusiasm and perseverance. She added that the competition, a successful first attempt with over 50 applicants, will likely be repeated.

With a total of 12 winners, the top three photographers received a VAIA cube loudspeaker made of wood – a blend of nature, craftsmanship, and technology. The speakers are made of trees felled by winds in the Dolomites, Italy, in 2018. The remaining nine winners received a set of gardening tools.

The winners are:

- **Dominika Koszowska** from Poland with ‘Treasure under our feet’, capturing the beauty of soil as a treasure with a focus on the contrast between plant greenery and soil brown;
- **Sergio Ibáñez Pascual** from Spain with ‘Flowering vineyard soil’, highlighting the role of soil as the foundation of all life, emphasising cover crops for soil management, biodiversity promotion, and erosion prevention;
- **Božidar Grgošić** from Croatia with ‘Desperate for life’, presenting a photo taken after river floods, symbolising the soil's need for attention and recovery.

Figure 9. Winners of the photo competition together with a DG AGRI representative

The remaining nine winners were: **Jacek Cisło** (Poland) with ‘Soil is the living organism of the earth’; **Eric Lucot** (France) with ‘Glacial memories of a soil’; **Félix González Peñaloza** (Spain) with ‘Holm oak surviving in red soil at

Cerro del Hierro'; **Mariya Maslova** (Croatia) with 'The soil under the 1 500-year-old olive tree in Croatia'; **Eniko Kelemen-Zobor** (Hungary) with 'Forest'; **Diana Joca** (Romania) with 'Connected'; **Knud Bay Smidt** (Denmark) with 'Soil for Generations'; **Cristina Mancini** (Italy) with 'Let's save this land!'; and **Marcin Świtoniak** (Poland) with 'Colours of erosion'.

All 12 winning photos, including those from other participants, were incorporated into a calendar, which was gifted to the event participants and the winners themselves. Moreover, the 12 winning photos were presented during the event in a photo exhibition located in the main hall of the venue.

Day 2: Plenary sessions

6. Keynote speech: Social, economic, and cultural transformations for soil health

Social, economic, and cultural transformations for soil health by Anna Krzywoszynska, Mission Soil Board Member

Figure 10. Anna Krzywoszynska presenting the session 'Social, economic, and cultural transformations for soil health'

'We need to do some important foundational work on understanding how different areas of social life impact and connect with soils.' – Anna Krzywoszynska

In her keynote speech on social, economic, and cultural transformations for soil health, Anna Krzywoszynska emphasised the need for a **holistic approach to restore European soils, involving social, cultural, and economic changes**.

Anna Krzywoszynska began by illustrating how human society impacts the hydrosphere, ecosphere, atmosphere, and lands, emphasising that current **changes in land systems pose risks to human society on Earth**. She presented art depicting houses encroaching on farmlands, providing a specific and powerful perspective on the environmental impact.

Anna Krzywoszynska then highlighted the **Critical Zone conceptualisation by Professor Steven Banward**, focusing on specific places where regenerating and degenerating soils occur. The Critical Zone, a space of liveability between tree canopies and the lithosphere, underscores the importance of soil in this ecosystem. She further emphasised that **justice considerations, including inter-species, inter-generational, and intra-generational justice**, are crucial when addressing environmental issues.

Anna Krzywoszynska referred to documents like the Stockholm Resilience Centre's planetary boundaries and the United States Global Change Research Programme's climate assessment, emphasising the importance of justice in environmental policies. She stressed the need for foundational work on **understanding the impact of different aspects of social life on soils**, encouraging improvements in pre-existing relations, such as crop diversification and waste management.

Krzywoszynska pointed out that transformation, not just transition, is essential, requiring **changes in values, perceptions, and interactions at institutional, cultural, economic, and political levels**. She advocated for a co-production process in achieving sustainability transformations, referencing the FAO's re-thinking of SDGs related to soil health.

Krzywoszynska called for **research on societal and cultural approaches to soils**, posing questions about the impact of globally traded food-based financial products, collective values in forestry, and historical inequalities in

access to green space. Trans-disciplinarity is essential to understanding the dynamics of societal, cultural, political, and economic aspects. She emphasised the need to **work with agents of transformation**, citing existing examples like community-supported agriculture and farmers' socio-ecological justice movements and citizen science groups around soil pollution.

In conclusion, Anna Krzywoszynska highlighted the importance of **transdisciplinary approaches in Mission Soil** and emphasised that the arts are not just a means to communicate research but are research themselves, offering new perspectives. She illustrated this point with Agnes Denes' project 'Wheatfield – A Confrontation', which brought nature and agriculture to the centre of Manhattan.

7. PREPSOIL project: supporting the Mission Soil

7.1 PREPSOIL and its work to support the Mission Soil

Line Friis Lindner, Director at the Danish Centre for Food and Agriculture (DCA) and Coordinator of PREPSOIL

Line Friis Lindner highlighted the key aspects of the EU-funded project's work in support of the Mission Soil.

PREPSOIL, initiated as one of the first projects under the Mission Soil, focuses on facilitating the deployment of the Mission across European regions during the induction phase and the roll-out period from 2022 to 2025. The project involves the **creation and implementation of tools and spaces for interaction, knowledge sharing, and co-learning** among diverse stakeholders to enhance soil literacy and awareness.

The project, which commenced in summer 2022 and extends until summer 2025, boasts a consortium of 20 partners from 11 EU Member States and Norway. These partners include multi-disciplinary academic entities, EU umbrella organisations, and multi-actor associations. PREPSOIL targets various stakeholders, including farmers, landowners, academic experts, organisations, NGOs, citizens, and local stakeholders. The overarching goal is to **connect and inspire these groups to take action in improving awareness and soil literacy**.

Structured around three impact pathways, PREPSOIL aims to increase soil literacy, awareness, and societal appreciation; enhance the knowledge base and access to critical information for actionable soil health improvements; and create interaction spaces for effective Mission deployment, aligning with EU and international commitments.

To boost citizen awareness, PREPSOIL engages with communities of practice through **video interviews**, showcasing their work on the PREPSOIL YouTube channel. The project also conducts an **open call for soil advocates**, gathering over 100 volunteers and keeping them engaged through interviews and feedback collection.

PREPSOIL also invites **best teaching practices for healthy soils** through an annual open call, allowing teachers from primary to secondary schools to share inspirational materials. The project has also established a **knowledge hub**, a multilingual repository for soil health materials, open for submissions and organised by an editorial team. Additionally, PREPSOIL is developing a **web forum for stakeholders and communities of practice** to engage in discussions, network, exchange knowledge and share documents.

7.2 Identifying soil needs: the PREPSOIL regional approach

Saskia Keesstra, Senior Researcher at the Wageningen Environmental Research (WUR) and Lead on soil needs assessment in PREPSOIL

'It's not just what the soil needs, it's also about what we need from the soil.' – Saskia Keesstra

Saskia Keesstra outlined the PREPSOIL project's objective: identifying existing soil needs in diverse regions across EU Member States and Associated Countries, representing the main European pedo-climatic zones and land uses.

Figure 11. Saskia Keesstra presenting the session 'PREPSOIL project: supporting the Mission Soil'

The term 'soil needs' refers to the requirements from socio-economic and geo-biophysical perspectives, both existing and emerging, that influence soil health and related services to human society. It encompasses not only what the soil needs but also what society requires from the soil.

To achieve this, the project deliberately selected a broad spectrum of regions, ensuring representation of various key identifiers such as land uses, environmental zones, soil types, and accessibility. A region, as defined by the project, should predominantly feature a specific land use while interacting with at least one other land use. It should share common drivers causing current unsustainable land/soil management and exhibit sustainable management practices. Ultimately, 20 regions were identified and mapped.

Each region underwent a workshop with stakeholders and approximately 10 targeted interviews with specific members of society. This process resulted in the creation of 20 posters, each providing information on the regional soil needs. The outcomes from these workshops will contribute to a synthesis report detailing soil needs and drivers of changes for each land use type. This information will be pivotal in formulating recommendations for co-creating

innovative activities to enhance soil health, as well as establishing new Living Labs and Lighthouses. Interested individuals can find these posters on the PREPSOIL website.[3]

7.3 Soil needs assessment in 20 European regions: method and key results

Katharina Helming, Co-Head Research Area 3, Agricultural Landscape Systems at the Leibniz Centre for Agricultural Landscape Research (ZALF)

'It is important to boost a sense of ownership and belonging in people when it comes to their local soils.' – Katharina Helming

Katharina Helming shared insights from the **PREPSOIL project's soil needs assessment** in 20 European regions, employing the DPSIR approach. This method analyses human–environment interactions, with DPSIR standing for drivers, pressures, states, impacts and responses in different systems.

Figure 12. Katharina Helming presenting the session 'PREPSOIL project: supporting the Mission Soil'

The assessment comprised three steps: a **literature study** of soil needs and stakeholder inventory, a **stakeholder workshop**, and **approximately 10 interviews**, resulting in a summary of soil needs for each region, engaging over 500 individuals.

Key findings indicate that **regions typically address multiple Mission Soil objectives concurrently**. The drivers of soil management encompass **policy-economy, socio-culture, environment and technology**. Agriculture faces

[3] https://prepsoil.eu/

barriers to implementing soil-improving solutions, requiring **redesigning of policies** like the CAP to support ecosystem services and integrate agro-ecological principles with modern technologies.

In forestry and natural land, Katharina Helming highlighted that **halting peatland drainage and adapting forest management to climate change** are critical. Urban and industrial areas should prioritise **nature-based solutions**, **de-sealing** where possible, and supporting **community-led greening activities**. Novel approaches to housing and remediating industrial sites are also essential.

Katharina Helming also pointed out that mixed-land uses necessitate **training and cooperation among land users** due to their increased complexity. Climate change adaptation, awareness of heightened risks, addressing rural exodus, and implementing long-term land tenure systems are crucial soil needs in these areas.

7.4 Implications for stakeholder interaction, Living Labs, monitoring, science–policy

Line Friis Lindner, Danish Centre for Food and Agriculture (DCA), Aarhus University, PREPSOIL Project Manager

Line Friis Lindner started by pointing out that PREPSOIL's website features a **map of Living Labs and Lighthouses**, serving as inspiration for networking with contact information and filtering options. A **self-assessment tool**, soon to be published, will evaluate the maturity level of these entities to support them in identifying areas for improvement.

The project collaborates with Living Labs to generate model business plans through co-creation workshops, aiming to create a **service package with recommendations** for the Mission Soil.

Regarding monitoring, PREPSOIL evaluates soil indicators across land use types, synthesising results in a **2024 report on national and EU soil monitoring systems**. The project explores satellite-based Earth observation techniques and integrates citizen science and crowdsource data through a **mobile app**, promoting public engagement and capacity building for decision-makers.

PREPSOIL ensures **policy feedback** by developing science–policy interface protocols, best practices, and guidelines for science–policy interaction, with pilot testing in selected regions.

Engaging with stakeholders, PREPSOIL plans to **expand European Joint Programme (EJP) SOIL Hubs into multi-actor forums** at the national level, contributing to the soil info repository and fostering awareness through workshops, case studies, and communication efforts via the development of a knowledge hub and a forum. Line Friis Lindner urged participants to **visit the PREPSOIL website and read their blog posts for further details**.

8. The Mission's regional and local dimension

The session started with **Francesco Molinari**, Project Manager of the Mission-funded HuMUS project, highlighting the achievements of the project's first year, including **policy briefs** on EU funding opportunities and instruments to incentivise and reward healthy soil management and a forthcoming **training programme**. HuMUS launched a **call for pilot projects** to engage local and regional communities in the protection and restoration of soil health.

This was followed by **Raquel Bravo Rubio**, Chief of Communication and Institutional Relations Department at the City of Madrid, who talked about their project ‘Bosque Metropolitano’ (Urban Forest) connecting green areas to enhance biodiversity and city sustainability. Raquel Bravo Rubio pointed out that **citizen consultation** was crucial, with **five master plans** emphasising soil and land use management conditions. In addition, an **educational campaign**, including materials for schools and street initiatives, aimed to raise awareness of nature's importance.

Angèle Liaigre, EU Project Adviser Cities and European Regions Research and Innovation Network (ERRIN) Bioeconomy Working Group Leader at Northern Netherlands, emphasised the city of Leeuwarden's efforts in **banning herbicides, analysing soil typologies, and developing tools for urban planning**. Their 'Give a shit' campaign raised awareness about nutrient cycles using human waste.

On citizen engagement, all speakers agreed that **citizens are generally unaware of soil health's importance**. They clarified that this was not due to indifference but to the fact that soil health is not seen as a priority by most people. Francesco Molinari stressed the potential shift if people understood the impact on their children's well-being, for example. Raquel Bravo Rubio highlighted **educational campaigns targeting various age groups**, while Angèle Liaigre noted the emerging priority of soil health in their cities.

The moderator inquired on the level of citizen engagement, and all speakers agreed that awareness is currently low, though Raquel Bravo Rubio shared positive experiences with educational initiatives in Madrid. They acknowledged the **growing momentum** but emphasised the need for **further development in making soil health a priority**.

During the question-and-answer session, an audience member highlighted the importance of **connecting citizens with farmers**, suggesting the transformation of urban gardens into horticultural spaces to emphasise the link between soil health and food.

Angèle Liaigre praised the bottom-up approach of Mission Soil and stressed the **role of regions and cities in facilitating local dialogues** for citizen engagement. Raquel Bravo Rubio shared initiatives in Madrid, such as recovering natural soil in schools, establishing community orchards, and engaging citizens in productive plots. She emphasised the need for **awareness about food production in big cities**. Francesco Molinari emphasised that people may not be aware of soil problems but understand their implications. He stressed the instrumental reason for **engaging citizens to mitigate the negative impacts** of human activities.

An audience member stressed the importance of food in the Mission, referring to the Rodale Institute's motto, ‘healthy soil is healthy food, is healthy people’. Another audience member shared a US survey revealing a disconnect between children and citizens' understanding of food sources.

Regarding business models, a question was asked about **priorities in land managers' interests**.

Raquel Bravo Rubio mentioned a programme collaborating with companies to plant in Madrid for carbon footprint compensation. Francesco Molinari shared the example of a French city using soil parameters to assess the impact of urban development projects. Raquel Bravo Rubio further emphasised the collaborative process with landowners in Madrid's urbanisation.

In the concluding advice, Francesco Molinari stressed the importance of **consistency**, Raquel Bravo Rubio advocated for **innovation for all citizens of all ages**, and Angèle Liaigre highlighted the crucial **roles of regions, cities, culture, and arts** in making soil concepts accessible.

9. Mission Manifesto and Mission Ambassadors

9.1 Testimonials from Mission Soil Manifesto signatories

Kerstin Rosenow began with an overview of the Mission Soil Manifesto, emphasising its collaborative creation. Despite potential administrative challenges for public authorities, she highlighted the Manifesto's value and its **open invitation for signatures from various entities**. As of 6 November, the Manifesto had garnered 1 753 signatures, with 80 % of its individual signatories based in the EU, mostly engaged in research. Among legal entities, 87 % are EU-based, with the private sector comprising 37 %. Rosenow stressed the need to further **raise the Manifesto's profile**, especially encouraging more regions, cities and municipalities to join the initiative.

The overview was followed by a presentation by **Maria Cruz Ferreira Costa**, Director General of the Regional Secretariat on Energy, Sustainability and Climate Action of the Region of Murcia. She highlighted the challenges faced by the Murcia region, including high temperatures, water scarcity and the risk of desertification. Despite these challenges, the region has implemented projects like Adaptation and Mitigation at Municipal Level and is establishing a carbon register. She emphasised the importance of **governments at all levels signing the Mission Soil Manifesto** to promote soil health. Maria Cruz Ferreira Costa also pointed out that there are more than 118 000 hectares dedicated to organic farming in Murcia, which corresponds to **32 % of the total cultivated area**. Between 2022 and 2023, the regional government has granted to organic farming EUR 44 million (national and EU funds).

José Miguel de Paz Bécares, Researcher at Instituto Valenciano de Investigaciones Agrarias, gave an overview of the soil issues in Valencia, including erosion, salinity, and nitrogen contamination. As a good practice, he pointed out the local farmers in Valencia who use **smart strategies such as terracing and alternative water sources**. The region tackles nitrogen pollution through regulations and promotes organic farming using CAP eco-schemes. José Miguel de Paz Bécares said that the Generalitat Valenciana signed the Manifesto because they were very concerned with the process of soil degradation in their region and thought it was a **great way to promote the concept of soil health among their farmers**.

Figure 13. José Miguel de Paz Bécares, Maria Cruz Ferreira Costa and Sasha Twining (Moderator) during the session 'Testimonials from Mission Ambassadors'

In a video message, **Frida Nilsson**, alternate member of the European Committee of the Regions, Lidköping Municipality, emphasised the **universal importance of soil health**. She stressed the need for **flexibility in monitoring and assessment** to account for local conditions, especially when dealing with the significant **economic costs of soil degradation**. Nilsson pledged to leverage her position to raise awareness among local and regional politicians throughout the EU.

Livia Lazzarotto, Policy Officer at the Directorate for Agriculture and Rural Development of the Tuscany Region, elaborated on soil challenges specific to Tuscany, including low organic carbon, erosion and salinisation. The region actively promotes **organic farming** (34 % of agricultural land – above the EU average), implements **soil-friendly cultivation techniques**, and allocates substantial EU rural development funds for **soil-specific measures**. Lazzarotto emphasised the need for collective action to ensure a healthy environment for current and future generations.

Overall, the speakers stressed the urgency of addressing soil health, called for the **support of local and regional governments** and highlighted the **shared responsibility** in building a sustainable future for Europe.

9.2 Testimonials from Mission Ambassadors

DG AGRI launched during the EMSW a new voluntary scheme to promote the Mission Soil: the Mission Ambassadors. The first two Mission Ambassadors to be nominated were: Yanniek Marijn Schoonhoven and Alfred Grand.

Figure 14. Portrait of Yanniek Marijn Schoonhoven

Yanniek Marijn Schoonhoven, regenerative organic farmer and co-founder of the Regeneration Academy, shared that being a Mission Soil Ambassador aligns with her daily work caring for the soil on her farm. She sees it as an honour to **spread awareness further**, a commitment reflected in the Regeneration Academy's work of promoting regenerative practices and sustainable agriculture among students, professionals and researchers.

Figure 15. Portrait of Alfred Grand

Alfred Grand, a farmer and owner of GRAND FARM and former member of the Mission Soil Board, revealed that becoming an Ambassador was an easy decision for him. As a food producer, he emphasised the critical **link between healthy soil and healthy food**, stating that being a Mission Soil Ambassador is an honourable responsibility.

Discussing the gaps, they aim to fill and the inspiration they wish to provide. Grand, as the owner of a research farm, highlighted the **practical impact of research**. He and Schoonhoven, as Mission Soil Ambassadors, promote soil health to various audiences, including children, students, adults, scientists, and visitors at their farms. Grand's farm serves as a **research and demonstration site**, engaging people in understanding the importance of soil health. Schoonhoven shared their **collaboration with local secondary schools** in Murcia, conducting talks on climate change and soil health, and hosting visits to their farm.

She expressed her role in convincing other farmers to change their approaches and her desire to set up a Living Lab in the wider region.

Figure 16. Yanniek Marijn Schoonhoven, Alfred Grand and Sasha Twining (Moderator) during the session 'Testimonials from Mission Ambassadors'

When asked about activities with children on the farm, Grand described an initiative where participants used pigments from the earth, linking art to soil health awareness, to produce paintings that were then exhibited on several occasions. Schoonhoven also highlighted the **launch of the European Association for Regenerative Agriculture**: a farmer-founded organisation dedicated to regenerating soil health in Europe. Both speakers emphasised the multi-stakeholder approach of the Mission Soil, highlighting the **unity among farmers** across Europe in agreeing on similar soil principles while allowing for **contextual differences in implementation**.

Day 3: Plenary sessions

10. EUSO: State of play, developments, and achievements

Panos Panagos, Project Officer at the Land Resources and Supply Chain Assessments Unit, JRC, European Commission, provided an overview of the EUSO and its achievements over the past two years. The EUSO aims to support soil policy with EU-wide soil monitoring, a robust ESDAC, R&I, and a Stakeholder Forum.

Figure 17. Panos Panagos presenting the session 'EUSO: State of play, developments, and achievements'

Key achievements include the development of the EUSO dashboard, and support for the recently proposed Soil Monitoring Law, involving collaboration with DG ENV and the European Environment Agency. Notably, the EUSO actively contributed to the **Mission Soil evaluation**, the **Nature Restoration Law**, the **Clean Soil Outlook**, the **carbon removal certification**, and the **review of the CAP performance indicators**. These actions are summarised in the EUSO Annual Bulletin.

Panos Panagos highlighted the importance of the **EUSO dashboard** launched in 2020, offering insights into soil degradation across the EU. LUCAS 2022 played a pivotal role in soil health assessment, and EUSO collaborated with the EJP SOIL to enhance laboratory analysis for the proposed Soil Monitoring Law. EUSO also contributed to the European Environmental Agency (EEA) Zero Pollution Monitoring Report.

In terms of R&I, EUSO collaborates closely with the Mission Secretariat. Panagos emphasised the significance of this project for hosting Mission Soil data. He further added that despite being a small team, EUSO produced over **40 peer-reviewed publications** in 2022, **mentored Collaborative Doctoral Partnership PhD candidates** and **engaged in diverse Mission-funded projects** like: AI4SoilHealth; BENCHMARKS; Soil Biodiversity and Functionality of Mediterranean Olive Groves (Soil O-LIVE); PREPSOIL; Engaging Citizens in Soil Science: the Road to Healthier Soils (ECHO); and MARVIC (Developing and Testing a Framework for the Design of Harmonised, Context-Specific MRV Systems for Soil Carbon and Greenhouse Gas Balances by Agricultural Activities).

The presentation touched on various assessments, including those on **climate sensitivity of soil organic matter, policy implications of soil erosion in farmlands** and the **phosphorus budget for Farm2Fork**. The **ESDAC**, established in 2010, has seen significant progress, providing crucial data for policies, with a plan to update it further with new data flows coming from monitoring programmes and data from Mission-funded projects. Over the past 10 years the data centre website has had over **70 000 data downloads** (around 10 000 data downloads in 2022) and more than **350 000 visitors per year**.

Figure 18. Arwyn Jones presenting the session 'EUSO: State of play, developments, and achievements'

EUSO actively engages in citizen awareness, participating in conferences, and organising events like the JRC Summer School. Panagos also highlighted the JRC Soil Atlases, which serve as educational material for public communication events. In addition, the **third Stakeholder Forum** in November 2023 had **over 700 participants**, focusing on Mission Soil projects.

Regarding the future, EUSO aims to develop a **revised version of the LUCAS Soil Module**, **update the dashboard and ESDAC** with more data flows, develop a **policy dashboard** and strengthen **collaboration with Mission Soil projects**. Major outputs for the next year include the State of European Soils Report and assessments on EU Biodiversity and Antimicrobial resistance, and a methodology to describe land degradation and desertification assessment.

Panos Panagos also responded to inquiries from the audience.

One question sought clarification on the **connection between the tools within EUSO and the proposed database in the Directive on Soil Monitoring and Resilience**. Panagos explained that EUSO currently provides scientific evidence and anticipates playing a key role in supporting the implementation of the recently proposed Soil Monitoring Law. He emphasised EUSO's potential role as a data repository, holding data flows from Member States.

Another query focused on **how EUSO plans to assist countries in implementing the proposed Soil Monitoring Law**. Panagos acknowledged EUSO's experience but highlighted the need to learn from countries with more expertise in data management and monitoring. EUSO aims to provide data for national assessments and reports while encouraging countries to replicate successful approaches.

The third question delved into **tracking technological and soil health changes**. Panagos expressed belief in the transformative impact of technology, particularly remote sensing, but underscored the ongoing importance of sampling and laboratory analysis for EUSO.

The final question addressed **EUSO's potential role in complementary coordination between projects**. Panagos agreed on the necessity of complementarity and suggested organising clusters based on themes like data and indicators. He emphasised the importance of collaborative efforts to maximise the impact of various projects.

11. Assessing soil health at different scales across Europe

Teresa Pinto Correia, Professor at the University of Evora and Member of the Mission Board, emphasised the timeliness of the Mission Soil, highlighting the need for increased investment in soil and soil regeneration. She stressed the importance of **tailoring the construction of Living Labs** and involving stakeholders in regional contexts, emphasising that there is no one-size-fits-all solution. Teresa Pinto Correia highlighted that land management is region-specific and soil health changes depend on various factors, including socio-economic and cultural aspects, which are **better understood and addressed at the local level**. She mentioned the SoilReCon project in Portugal as an example, showcasing the benefits of downscaling to reveal more precision in vulnerability assessments and the identification of diverse stakeholder sub-groups.

Figure 19. Teresa Pinto Correia presenting the session 'Assessing soil health at different scales across Europe'

As a conclusion, Teresa Pinto Correia highlighted the significance of scale in addressing soil-related issues. The idea is that **not all issues can be effectively tackled at the same scale**. To engage with soil managers effectively, a focus on the local level is essential. Thinking across various scales makes it possible to comprehend the factors influencing changes in soil management. Teresa Pinto Correia called for an approach that involves creating typologies and groups. The suggestion is to develop **mosaics of soil districts**, each with its local communities of stakeholders, to better understand and address soil management challenges.

'Scale matters. Not all issues can be addressed at the same scale. If we want to address those who manage soils, we need to look at the local level.' – Teresa Pinto Correia

Rachel Creamer, Professor at Wageningen University and Coordinator of the BENCHMARKS project, discussed the need for **indicators that are fit for purpose** in transitioning land and soil management towards healthier production. She underlined the convergence of political and industrial pressures towards regenerative agriculture and sustainable landscapes. Creamer provided an overview of the evolution of soil health indicators, emphasising the shift from primarily chemical indicators to a more holistic approach, including physical and microbial factors. She stressed the importance of **harmonising data collection across Europe**, supporting the recently proposed Soil Monitoring Law.

Creamer highlighted the BENCHMARKS project's focus on **starting at the local level**, engaging stakeholders to define meaningful indicators that drive soil change. To do that, the project works with 24 landscapes across Europe. They work with local farms, forests and urban areas. The project started with **multi-stakeholder workshops** where people come together to discuss the challenges they are facing in their regions in terms of soil health and what soil information they need.

Figure 20. Rachel Creamer presenting the session 'Assessing soil health at different scales across Europe'

'If we want soil change, we have to start from the local level. This will have the knock-on effect to help us increase the soil health in Europe.' – Rachel Creamer

Creamer emphasised a shift in understanding soil functioning by **focusing on soil processes rather than soil properties** as the fundamental underlying system. The approach involves collecting comprehensive information, including physical, chemical, and biological aspects, along with details on management practices and environmental conditions for each soil process. This holistic data collection aims to define meaningful indicators and establish a logical sub-system. The ultimate goal is to determine appropriate measures of application, enabling the **generation of reports that are both meaningful and fit for purpose** at the relevant scale.

Mogens H. Greve, Head of Research Section at Aarhus University, presented the AI4SoilHealth project, which aims to establish an **open-access European digital infrastructure** for assessing and monitoring soil health

metrics based on land use and management. The project includes various work packages focusing on soil health indicators and the subdivision of Europe into **soil districts for meaningful benchmarking**. The team explores **innovative soil health proxies**, including water repellence and tree diseases, employing methods like soil spectroscopy and molecular arrays.

'Soil districts are a great tool to approach farmers. They also offer more feasible sampling when it comes to monitoring.' – Mogens H. Greve

Additionally, they aim to create a **Soil Digital Twin**, integrating landscape data for accurate predictions of soil properties. The final list of indicators considers policy relevance, signal-to-noise ratio, practicality and cost efficiency. The project involves **28 partners across 14 European countries, with 13 pilots covering 11 pedo-climatic regions**. The main outcome is a '**data cube**' accessible through mobile apps and online tools, allowing users to generate and analyse data layers.

Figure 21. Mogens H. Greve presenting the session 'Assessing soil health at different scales across Europe'

Greve emphasised that the project employs a **top-down approach**, delivering pan-European and national-level analyses while allowing direct farmer interaction. Soil districts facilitate farmer comparisons and offer **practical sampling for monitoring soil health**. The predictions' quality improves over time with accumulating monitoring data.

12. Panel discussion on soil monitoring and indicators

Moderated by **Rachel Creamer** and **David Robinson**, UK Centre for Ecology and Hydrology, the panel discussion delved into crucial aspects of soil monitoring indicators, featuring insights from diverse experts. The discussions encompassed diverse themes such as **knowledge gaps**, **local-scale approaches**, **integrated monitoring**, and **stakeholder engagement**.

Figure 22. Panellists during the discussion 'Soil monitoring and indicators'

Anne-Catherine Dalcq, representing the European Council of Young Farmers, highlighted the challenges faced by farmers in understanding soil health. She emphasised knowledge gaps, especially in biological health indicators, and the need for **reliable information to implement soil health practices**. Dalcq also discussed challenges related to the **availability and timeliness of soil analysis**, particularly in the context of heavy rainfall affecting soil management practices.

Lastly, she highlighted the **prices of agricultural equipment**, which have skyrocketed recently. For farmers to afford this equipment, they would have to raise their prices, which would put them at a disadvantage with the competition. Dalcq pointed out that pooling or sharing equipment is rarely possible, as there is often competition between neighbouring farms.

Erwin Szlezak, Head of Unit at the Soil Protection & Landscape Planning Section in Lower Austria, discussed his role as a regional policymaker. He emphasised the importance of the **local scale in creating effective management practices**, drawing attention to Austria's agro-environmental units and sub-units as a potential model for soil districts. Szlezak stressed the need for **local-level data** to support farmers in adopting best management practices.

Luis Sánchez Álvarez, Head of Sector at DG AGRI, R&I Unit, provided reflections on the challenges of assessing and monitoring soil health. He underscored the significance of obtaining comprehensive **information at the local level to facilitate continental-level assessments**. Luis Sánchez Álvarez emphasised the need for **well-founded**

baselines, clear indicators and reliable data at various levels, including EU, regional, sub-regional and local levels, to inform effective policymaking.

Nina Koele, senior soil scientist from the Ministry for the Environment of New Zealand, shared New Zealand's approach to soil health. She discussed challenges related to setting up a monitoring system and regulations due to limited access to privately owned lands. Koele reminded that New Zealand is a **bi-cultural society**. She added that **place-based knowledge** in New Zealand is extremely important because local tribes hold the knowledge and customs associated with managing their resources.

'In Europe there are a lot of culturally different countries, and some people are concerned that the Soil Monitoring Law may not apply to their national context. But I think European countries have a lot to learn from each other.' – Nina Koele

Arwyn Jones, Deputy Head of Unit at the Land Resources and Supply Chain Assessments Unit, JRC, European Commission, highlighted the challenges and importance of implementing a monitoring programme on a European scale.

When asked about the requirements for such a programme, Jones emphasised the need for **on-field data collection**, especially for developing machine learning approaches. He referred to LUCAS, initiated in the early 2000s, which aimed to create a **harmonised standard dataset for monitoring forest soils**. The goal was to avoid issues arising from different sampling and lab approaches used by individual countries. Jones clarified that the focus is on **understanding key trends in soils at the farming system and bio-climatic region levels**, rather than individual farmer practices.

In terms of scale, the LUCAS programme involves around **500 surveyors collecting over 20 000 samples, with 40 000 collected in the 2022 survey**. Challenges exist, such as access to private land and confidentiality issues. However, some soil characteristics are intrinsic and not tied to specific management practices, making certain data shareable.

Regarding soil pollutants, Jones mentioned **confidentiality concerns**, leading to aggregated data for regional trend analysis rather than public disclosure. He also touched upon initiatives like the CAP and the Soil Strategy, which proposes free soil testing for landowners. Jones envisioned a future where all landowners could **test and share soil data in real-time**.

When questioned about soil districts, Jones clarified that according to the Soil Monitoring Law, the **responsibility for defining soil districts lies with the countries**. The Commission's role is to support Member States in determining representative soil districts, considering discussions on the relationship between soil characteristics, climate, and land use in shaping these districts.

Bridget Emmett, Head of Soils and Land Use Science Area at the UK Centre for Ecology and Hydrology, provided insights into their 45 years of experience in running monitoring programmes.

Emmett highlighted the challenge of obtaining a nationally representative sample, emphasising the importance of **data from various land use types beyond just farmlands**. National governments are keenly interested in this data to assess the effectiveness of policies. Despite the pressure to adopt the latest technology, Emmett stressed the **value of fieldwork**, as certain indicators can only be obtained through live sampling.

She explained that **their soil monitoring programme is integrated**, covering not only soil but also various aspects of the landscape, including birds, pollinators, ponds, headwaters and cultural features. This comprehensive approach allows them to report on national trends and **recognise the interconnectedness of ecosystems**. Emmett emphasised the enduring success of a **design developed in 1978, deemed unbeatable by independent statisticians**. The design, nested in landscape elements, remains consistent over time.

When asked about her experience with indicators, Emmett emphasised the need for a **simple set of core indicators that people can understand**. This approach allows for flexibility in expanding or contracting based on funding availability. By maintaining a consistent set of measurements, they have created benchmarks for **over 129 different soil-land use-climate combinations**, providing valuable insights into soil health.

Teresa Pinto Correia, Professor at the University of Evora and Member of the Mission Board 'A Soil Deal for Europe,' discussed the need to **make soil-related information more understandable** and interesting for family farms. She emphasised addressing the knowledge gap and using motivating language, particularly in engaging with family farms through Living Labs.

Maria J. I. Briones, Professor of Zoology at Universidad de Vigo and Coordinator of the Mission-funded project Integrating SOil Biodiversity to Ecosystem Services (SOB4ES), focused on soil biodiversity. Briones highlighted her project's approach, considering both spatial and temporal scales when studying microorganisms. She emphasised the importance of **selecting representative ecosystem variations and sampling comprehensively**.

Diego Soto Gomez, a postdoctoral researcher at the Universidad de Vigo and Coordinator of the Mission-funded project InBestSoil, shared insights into their approach to engaging different stakeholders and addressing economic aspects.

Diego Soto Gomez explained that their project begins at the Lighthouse or Living Lab level and aims to establish **connections with other initiatives in the area**. For instance, if a Living Lab focuses on agriculture, they initiate a local stakeholder network involving farmers, policymakers, and NGOs. As the project progresses, efforts are made to link these initiatives with local projects, **fostering a dialogue** to identify common challenges, shared indicators, methodologies, and funding sources.

To gather comprehensive perspectives, the team conducts **interviews with various individuals** to assess their satisfaction with the incentives provided. At the international level, they seek **involvement from major organisations and associations** to gain a broader understanding of the problems. However, Diego Soto Gomez acknowledged a challenge in engaging these organisations due to their involvement in numerous issues, often lacking the necessary resources for focused collaboration.

The question-and-answer session began with an audience member, a farmer from Galicia, expressing concerns about the unclear **connection between food waste and soil health**, emphasising the need for farmers to understand their role in this relationship.

A comment from the audience touched on the **effectiveness of Living Labs**. Anne-Catherine Dalcq said she viewed them as a positive step, emphasising the importance of sharing good practices among peers to improve soil health.

Concerns were raised about harmonising indicators across diverse soil types and the challenge of accommodating specific indicators used by farmers in different countries. Arwyn Jones highlighted the recently proposed Soil

Monitoring Law's intention to **complement existing national monitoring programmes** and discussed the potential for LUCAS to cover countries lacking operational systems.

The discussion also addressed the importance of **involving farmers in the design of measures** and the need for flexibility in setting dates for implementing soil health practices. Anne-Catherine agreed, stressing the importance of a **step-by-step approach** (e.g. focusing on organic matter first and then on reduced tillage) to achieve tangible results.

A question from the audience raised concerns about the **lag in monitoring**, stating that what is measured today reflects activities from years ago. The suggestion was for **forward-looking monitoring through modelling** to help policymakers trust farmers' choices.

Bridget Emmett responded, emphasising the necessity of **new models for future monitoring**. These models provide guidance to farmers on where to focus and what measures to apply. While acknowledging challenges in the face of new technologies and climate change, she stressed the importance of maintaining a **structured and consistent monitoring approach** alongside risk-based models.

Rachel Creamer highlighted the need to **work with landowners**, enabling them to perceive the transition themselves. She emphasised the importance of focusing on the local level, providing farmers with the skills and knowledge to assess if the transition is moving in the right direction.

Teresa Pinto Correia pointed out that some indicators change slowly, while others change rapidly. **Identifying dynamic indicators at the local level**, such as productivity or water retention, can motivate farmers by showing quick signs of improvement.

An audience member highlighted the complexity of land ownership, management, and operation involving different actors, stressing the need for **engagement with all relevant parties for effective change**.

Another attendee emphasised the challenges farmers face in obtaining quick soil analyses and interpreting results, urging policymakers to address the importance of **accessible labs and result interpretation** for improved soil health.

Regarding agricultural advisers, an audience member emphasised their crucial role, and Rachel Creamer mentioned the Mission-funded **project 'Nature-based solutions for soil management' (NBSoil) within Mission Soil, focusing on training advisers for updated knowledge**.

The global perspective on soil protection was discussed, with recognition of soil in UN conventions and a **call for a global soil biodiversity observatory**. Nina Koele agreed with the idea of having a global observatory or strategy.

The panel addressed the role of the business sector, with Luis Sánchez Álvarez emphasising the need for **strong, harmonised systems** beyond specific companies for credible information to consumers and investors.

Bridget Emmett highlighted the importance of **green finance**, emphasising the need to work with companies for long-term commitment and adopting a **system-based ecosystem approach**.

Concerning recognising good practices, Bridget Emmett discussed benchmark populations adapted to local contexts, showcasing those already excelling in soil management.

A member from FAO acknowledged initiatives like LUCAS as pioneers and expressed a desire to discuss further **recommendations for globally harmonised national systems**.

13. EUSO Stakeholder Forum: outcomes of the EUSO Working Groups

Arwyn Jones, Deputy Head of Unit at the Land Resources and Supply Chain Assessments Unit, JRC, European Commission, provided an overview of the EUSO Working Groups. He started with the Stakeholder Forum, which aimed to capture the discussions and outcomes, focusing on developing a knowledge platform supporting soil policy with five key objectives. The year 2023 marked the third Stakeholder Forum for the EUSO, serving as a vital opportunity to **engage with the soil user community at both the EU and global levels**. The event facilitated bilateral exchanges, sharing insights on Commission policy development and scientific requirements. Additionally, it allowed the EUSO to gain valuable insights into broader research community activities and user needs.

The Stakeholder Forum spanned three days, comprising six sessions to delve into each of the five objectives. With **over 700 registered participants and 60 presentations**, the event provided a robust platform for dialogue. Recordings and materials from the sessions are accessible online for further reference.

13.1 EUSO Working Group: Soil biodiversity

Cristiano Ballabio, Project Officer at the Land Resources and Supply Chain Assessments Unit, JRC, European Commission

Cristiano Ballabio presented the main findings of the EUSO Working Group on soil biodiversity.

EUSO conducted the first assessment of European soil biodiversity, resulting in **two important publications in high-level journals** (Nature Communications, Global Change Biology) focusing on bacteria and fungi, as well as eukaryotes. A forthcoming publication will detail the **outcomes of the work on anti-microbial resistant genes**, targeting several antibacterial resistance genes.

Ongoing projects include the **study of pesticide effects on biodiversity** and the **mapping of soil biodiversity at the European scale**. The group aims to present the initial maps soon. Additionally, research will explore the **connection between biodiversity and primary productivity**, as well as the **impact of climate change scenarios on soil biodiversity**.

Future work will involve examining the **relationship between soil biodiversity and the proposed Soil Monitoring Law**. The current focus on soil biomass respiration may expand to a more comprehensive assessment of soil biota, pending discussions with the European Parliament. Ballabio said that they also expect to collaborate with those involved in the field, including Mission Soil projects addressing soil biodiversity.

Ballabio pointed out that LUCAS biodiversity survey data, available for public use, is considered in addressing challenges posed by directives. He encouraged collaboration and welcomed data contributions. He highlighted that the ultimate goal is to **legislate biodiversity, providing standardised methods for the Soil Monitoring Law**.

13.2 EUSO Working Group: Soil erosion

Panos Panagos, Project Officer at the Land Resources and Supply Chain Assessments Unit, JRC, European Commission

Panos Panagos shared the main findings of the EUSO Working Group on soil erosion.

Established in 2021, the working group has **three primary objectives: supporting EU policies, creating a soil erosion community and contributing erosion data to various disciplines**. With 54 voluntary members, significant progress has been made over the past decade.

The group produced trend indicators on **water erosion**, assessed **wind erosion** in 2017, **crop harvest erosion** in 2019, and **tillage erosion** in 2022. Considering these processes collectively reveals the complex nature of soil displacement, not solely due to water erosion.

Panagos pointed out that they identified **gaps in knowledge**, specifically concerning gully and piping erosion, with plans to address these in the coming years. A critical topic was the **cost of soil erosion**, accounting for on-site effects and costs incurred by citizens (e.g. due to sedimentation, landslides, floods). An impact assessment showed erosion costs ranging from **EUR 16.5 billion to EUR 68.8 billion annually**. The working group on soil erosion contributed to the SML and estimated the **cost of sedimentation** to be around **EUR 2.3 billion to EUR 8 billion per year**, collaborating with the International Committee of Large Dams.

A notable achievement was the development of the **first European sediments database** (EUSEDCollab) in 2023, a collaborative effort with partners across Europe. The working group emphasised the importance of plot data for both modelling and monitoring.

Mission Soil projects were actively involved, with **specific work packages related to erosion**. AI4SoilHealth is working on a new soil erosion indicator considering soil stock, and the BENCHMARKS project explores erosion drivers at different scales and appropriate indicators. The Soil O-LIVE project focused on monitoring soil erosion in areas with olives, recognising their significant impact.

Panagos also highlighted that in 2022, the soil erosion working group organised a successful **workshop on soil erosion in the EU**, which addressed eight subjects. A special issue was organised, which received 15 papers, eight of which were accepted for publication. The ongoing collaboration and research efforts underscore the commitment to addressing soil erosion challenges.

13.3 EUSO Working Group: Soil pollution

Piotr Wojda, Project Officer at the Land Resources and Supply Chain Assessments Unit, JRC, European Commission

Piotr Wojda presented the main findings of the EUSO Working Group on soil pollution.

The group, focusing on soil pollution, examines its **impact on biodiversity, human health, and our lives**. Comprising citizens, academia, institutions, industry, and policymakers, they produced the **first soil outlook report** in the Zero Pollution Monitoring and Outlook Report, accessible on EUSO's website.

The group contributes to the EUSO Soil Health dashboard, aiming to **identify pollution locations and defuse pollution and contaminated sites**. Recent discussions centred on improving the recently proposed Soil Monitoring Law, establishing priorities for the Soil Health Dashboard, and integrating monitoring frameworks into one platform.

Figure 23. Piotr Wojda presenting the session 'EUSO Working Group: Soil pollution'

In addressing the international dimension, recent **presentations explored the effectiveness of the proposed Soil Monitoring Law for terrestrial ecosystem protection**, emphasising suitable indicators and the polluter-pays principle. The Global Soil Partnership and its role in identifying and remediating soil pollution were also discussed, providing guidelines for technicians, stakeholders and government representatives.

The **industrial perspective** on the proposed Soil Monitoring Law's impact on industrial soils, along with discussions on the **reuse and circularity of excavated soils**, were also part of the agenda. Specific aspects included examples of contaminated site management in Slovakia, focusing on five pillars and public awareness.

Another presentation delved into the mixture of **pesticides in soil and farmers' households**, as well as new or recycled monitoring methods aligning with the proposed Soil Monitoring Law's call for remote sensing in characterising soil pollution.

Discussions within the working group revolved around **indicators, groups of pollutants, the polluter-pays principle, heavy metals, pesticides, ISO standards and emerging contaminants, among others**. Leveraging the LUCAS topsoil dataset, the group conducted in-house studies, providing a European view on soil pollution, accessible online through the EUSO dashboard.

Future challenges involve strategically determining **interaction platforms and channels**, as well as a strategic **approach to address soil pollution from academia to policy**. The group anticipates input from Mission Soil projects in this regard.

Wojda highlighted that legislation needs a **list of substances** for regular monitoring and a **watchlist mechanism for emerging pollutants**. The group proposed a methodology for the watchlist, identifying substances of concern in European soils and emerging pollutants requiring monitoring.

13.4 EUSO Working Group: Soil data sharing and integration

Cristiano Ballabio, Project Officer at the Land Resources and Supply Chain Assessments Unit, JRC, European Commission

Cristiano Ballabio presented the main findings of the EUSO Working Group on soil data sharing and integration.

Ballabio highlighted the **dual nature of data** – useful yet potentially overwhelming. Managing vast datasets requires specialised systems to extract valuable information. EUSO currently stores various information types and is transitioning to a **new version of the ESDAC 2.0**. Ballabio pointed out that the working group, still in its early stages, aims to understand how Mission Soil projects will provide data and in what format for integration into EUSO.

He mentioned a keynote presentation by SoilWise, which detailed the development of a **prototype for a long-term knowledge and data repository**. The four-year SoilWise project, involving 15 partners, focuses on integrating diverse soil data types, extracting useful information, and storing it in accessible public platforms.

Discussions within the working group revolved around the **degree of inference needed from data**, acknowledging different layers, starting with knowledge extraction and progressing to AI. Concerns were raised about AI generating false information. Ballabio pointed out that SoilWise aims to integrate project data, providing **useful information in a publicly available format**.

Delivery timeframes for data became a point of discussion within the working group, with some projects proposing immediate delivery and others opting for the end of the project. Each approach has pros and cons, balancing data timeliness and usability.

Ballabio highlighted that **Soil O-LIVE had detailed a catalogue of the data types** they will provide, including metadata format and elements, ensuring appropriate licensing for online information sharing.

As key outcomes Ballabio emphasised the crucial role of **data management across projects**, highlighting varied approaches. He pointed out that no prevalent idea has emerged, necessitating further discussion. **Harmonising frameworks** for end-note remains unresolved, with competing platforms. As key issues, Ballabio identified **physical data storage**, **long-term support** for legacy data and software, **paradigm shifts** in data storage, and reliance on **external actors**.

13.5 EUSO Working Group: Carbon monitoring, reporting and verification

Cristina Arias Navarro, Scientific Officer at JRC, European Commission

Cristina Arias Navarro presented the main findings of the EUSO Working Group on soil carbon MRV.

Cristina Arias Navarro began by highlighting the European Commission's commitment to soil research, citing a recent review that showcased **over EUR 1 billion and more than 1 000 projects dedicated to soil carbon** funded through various R&I programmes. Notably, there has been a significant increase in attention to soil carbon research linked to climate change, with almost 40 % of projects in 2020 addressing this issue.

She said that the **ESDAC has been instrumental since 2006**, serving as a focal point for soil data, providing open access to harmonised soil-related information, including data on soil organic carbon at both European and global scales.

The technical working group on soil carbon was initiated in October 2022, focusing on coordinating research activities, exchanging information among stakeholders, and supporting the European Commission's proposal for a regulation establishing a union certification framework for carbon removals.

The first meeting of the working group addressed **supporting the Research Executive Agency** (REA) in collaboration with new projects on soil organic carbon MRV, including Mission Soil projects, EJP SOIL and ORCaSa. It emphasised the importance of soil carbon MRV and carbon farming, with the working group seen as a **key player in bringing projects together** to strengthen collaboration and avoid duplication of efforts.

Cristina Arias Navarro pointed out that collaboration with the ORCaSa project included **support for their international review of MRV initiatives**, revealing the lack of homogeneity in methodologies published by private companies and institutions. She emphasised that a **robust science-based methodology** is crucial for the success of carbon certification from DG CLIMA.

The recent third Stakeholder Forum explored how R&I can aid the EU Commission's proposal for **carbon removal certification**. Over 150 participants discussed baselines for certification and monitoring the CAP. The importance of **data from the Integrated Administration and Control System** (IACS) for improving soil models was also highlighted.

Looking ahead to 2024, the working group plans to provide **collaboration, networking, policy updates** and focus on **carbon farming**. They aim to organise a **mini-conference** to inform policymakers about the state of knowledge on soil carbon. Scaling down the MRV aspect, the group will explore **inorganic carbon and organic soil**, among others, and will provide a forum for young scientists with an upcoming **open call for abstracts**. She recommended subscribing to the mailing list for updates.

13.6 EUSO Working Group: Soil monitoring

Arwyn Jones, Deputy Head of Unit at the Land Resources and Supply Chain Assessments Unit, JRC, European Commission

Arwyn Jones presented the main findings of the EUSO Working Group on soil monitoring and awareness.

He started by pointing out that due to unforeseen circumstances affecting the regular focus on soil monitoring, the Stakeholder Forum decided to explore the potential of **collecting data through citizen science initiatives**. The aim was to understand the **methodological aspects** involved in designing a citizen science programme and how it could **complement traditional approaches** such as LUCAS, national soil monitoring systems, and serve as an alternative data flow for ESDAC. The group also delved into specific challenges associated with using data from citizen science projects.

The presentation included contributions from research foundations, the Mission Soil, and case studies conducted on local and national scales, attracting over 100 participants. The group acknowledged that citizen science plays a valuable role in data collection, **offering a targeted focus** and engaging people, contributing to **increased**

awareness of soil health. The discussion highlighted the need to integrate databases generated by citizen science into existing data frameworks.

Key issues related to citizen science were discussed, including potential **biases in data monitoring**, such as preferences for specific sites or overemphasis on urban or agricultural environments. **Privacy concerns** and the **sustainability** of citizen science initiatives were also addressed, given their tendency to be one-off efforts.

The group emphasised the importance of developing **quality-control measures** to ensure the accuracy of data collected by citizen science initiatives. This involves establishing **robust data cleanup** and quality-control procedures.

Looking ahead, the group expressed the desire to strengthen the community involved in citizen science, creating a **unique data collection pool**. Building on the work of the Horizon Europe project 'Efficient compact modular thermal energy storage system' (ECHO), which is conducting an inventory of previous **soil-related citizen science campaigns**, there are plans to bring this data into the EUSO domain for broader access.

Arwyn Jones extended an invitation to people to present their monitoring-related work, with a session planned for the monitoring group in the new year. Additionally, a **workshop on monitoring elements within the Soil Monitoring Law** is scheduled for the spring of 2024, providing an opportunity for reflection on user feedback from the European Parliament, the Committee of the Regions and other entities.

Arwyn Jones concluded by saying that the working groups are envisioned as **integrated processes** and aim to involve the broader scientific community, especially Mission Soil projects, as they are seen as crucial for advancing the science base in these activities. He said he hopes to gather real feedback from these projects in the coming year.

The presentations were followed by a **question-and-answer** session with the audience.

An audience member raised concerns about the **inclusion of plant nutrients like potassium, magnesium and zinc in the list of pollutants**, seeking an explanation. Piotr Wojda responded, clarifying that not all substances are toxic; some are essential for plant and nutrient cycles. The Commission collaborates with DG AGRI on nutrient management, conducting studies in-house. Panos Panagos added that they are **working on different scenarios of farming practices and cropping systems** to find the right balance, exploring how reducing nutrient inputs impacts on soils.

In response to a question about the **absence of organic chemicals and methods for measuring their bioavailability** in the recently proposed Soil Monitoring Law, Piotr Wojda acknowledged the focus on soil properties and indicated that the group has not delved into organic pollutants yet, but it's an area of exploration. Arwyn Jones clarified that the **Soil Monitoring Law does not forbid measurements of organic pollutants**, leaving it to Member States.

An audience member expressed satisfaction with the **inclusion of field data in the proposed Soil Monitoring Law** and inquired if other field data types, such as radioisotope measurements (radionuclides), soil truncation or gully evolution, would be considered. Panos Panagos explained the **openness to various measurements and proposals**, emphasising collaboration with the Mission Soil community.

The **impact of sewage sludge application on soil health** in terms of antimicrobial resistance genes was questioned. Piotr Wojda mentioned an ongoing study and offered to connect the audience member to a relevant EUSO colleague. Arwyn Jones added that they are also investigating potential pathways of microplastics from car-related sources.

A participant asked how their project, ISLANDR, could collaborate with the working group on pollution. Piotr Wojda highlighted **existing collaboration** and encouraged **the development of methodologies** by ISLANDR. He added that the new LUCAS pollution module will facilitate tracing pollution at the European scale.

Regarding the concept of **a soil pollution watchlist**, an audience member asked if **antimicrobials** could be included, not just antimicrobial-resistant genes. Piotr Wojda affirmed the possibility, citing the growing issue with sewage sludge and the methodology allowing the addition of substances to the watchlist. Arwyn Jones added that EUSO is working on a **report on antimicrobial resistance in soils**, which should be released in early 2024.

Concerning cross-cutting topics and potential gaps in focus among working groups, Panos Panagos stressed the current **collaboration and dataset sharing between working groups**. Piotr Wojda suggested seeking feedback from the community to identify **needs and potential new working group proposals**.

In response to a query about **assessing technology capabilities**, Cristiano Ballabio explained that, as scientists, they have knowledge based on experience but do not possess exhaustive information.

14. Closing ceremony

In her closing remarks, **Kerstin Rosenow** highlighted three key messages. Firstly, she emphasised the **positive response** to bringing farmers, foresters, and urban communities together, focusing on collaborative solutions. Secondly, she noted the **enthusiasm** in the room and emphasised the need to **sustain momentum** and assess progress next year. Lastly, Rosenow stressed the importance of **driving the Living Labs and Lighthouses approach forward**, aiming for real impact in the field through the ongoing dialogue initiated during the conference.

Sala Saastamoinen, Deputy Director General at JRC, expressed satisfaction with the success of the joint conference by the Mission Soil and EUSO. She emphasised the **critical role of healthy soils in achieving the European Green Deal**, especially considering recent extreme weather conditions. Saastamoinen highlighted concerns from EUSO, indicating that 60 % of European soils face degradation, impacting resilience and essential ecosystem services. The Soil Monitoring Law aims to address these issues through **increased data collection**, facilitated by the Mission Soil. Saastamoinen commended the Mission's dedication to supporting sustainable food production, climate change mitigation, and biodiversity enhancement. She emphasised the importance of **translating scientific knowledge for practical use** by farmers and land managers, urging agricultural advisory services and spatial planners to play a crucial role. Saastamoinen stressed the need for a **vibrant interdisciplinary research community** to achieve environmental goals, acknowledging Commissioner Iliana Ivanova's support. She concluded by thanking organisers and participants for their contributions to the conference's success.

Diego Canga Fano, Director of Quality Policy, Research & Innovation, Outreach at DG AGRI, expressed sincere gratitude to the Spanish Presidency and the Spanish National Research Council for hosting the conference. He acknowledged CSIC's significant role in Spanish soil science and its top participation in the Mission Soil. Canga Fano thanked the speakers for sharing expertise, emphasising that attendees gained a deeper understanding of Mission Soil actions and engagement strategies.

Highlighting the EU's **substantial investment in soil research**, totalling around EUR 1 billion over 40 years, Canga Fano announced the Mission Soil's plan to **invest an equivalent amount in just seven years** to accelerate soil health protection and restoration. He stressed the need for **collaborative bottom-up efforts**, involving Living Labs and Lighthouses to address local soil challenges effectively. Canga Fano called for increased **collaboration with Member States and the private sector**, noting that the estimated cost of sustainable soil management is significant, requiring new business models and heightened awareness of soil's value.

Canga Fano emphasised the **profitability of soil health** environmentally, socially, and economically, mentioning ongoing work with the European Investment Bank to collaborate with the private sector. He highlighted the historical opportunity presented by the proposal for the Directive on Soil Monitoring and Resilience, urging participants not to miss the chance to **establish a robust framework for soil health**. Canga Fano concluded by thanking all participants for their contributions and calling for leaving healthier soils for the next generation.

José Antonio Sobrino, Deputy Director General at the Ministry of Agriculture and Food of Spain, expressed gratitude to DG AGRI, the Mission Board, JRC, EUSO, and all stakeholders, including farmers, foresters, and land managers. He highlighted the significance of the Mission Soil Week in **raising awareness about soil health**, considering it an impactful event that involves all sectors and the entire population. José Antonio Sobrino acknowledged the **valuable work presented by Mission Soil projects**, addressing knowledge gaps, challenges and opportunities for transitioning to healthy soils.

Emphasising soil health as a priority in both the EU and Spain, José Antonio Sobrino aligned the ministry's commitment with the Commission's objectives. He stressed the need to **leverage the multiplier effect of Living Labs** for best management practices in agricultural soils. **Operational groups** were identified as crucial, especially in areas beyond the reach of Living Labs, to co-develop methods adapted to local conditions and share challenges among countries and regions. José Antonio Sobrino cited the PREPSOIL project as a positive example.

Recognising common challenges faced by farmers, such as climate change, drought, erosion, decreasing productivity and rural depopulation, José Antonio Sobrino advocated for supporting farmers in improving soil health through **advisory services** and **locally adapted agricultural practices**. He underscored the importance of monitoring and harmonisation for the proposed Soil Monitoring Law, praising EUSO's role in providing soil data assessment for monitoring soil and policies.

José Antonio Sobrino celebrated the **launch of the IRC Soil Carbon** during the EMSW, highlighting its collaboration with various initiatives to foster synergies and construct research. He commended CSIC's capacity in soil research, exemplified by its success in EJP SOIL, emphasising its strategic value for the Mission Soil. José Antonio Sobrino stressed the ministry's role in supporting research, establishing networks and communicating the importance of soil health to society.

In closing, Sobrino encouraged the soil community to **capitalise on the momentum generated during the Mission Soil Week**, harnessing the energy and experiences to fulfil the Mission of achieving soil health goals.

Maria Jesus Rodríguez de Sancho, Director General of Biodiversity, Forests, and Desertification at the Ministry of Ecological Transition of Spain, emphasised the significance of the conference as a pivotal moment for sharing regional and local experiences in addressing soil challenges. She highlighted the importance of healthy soils for achieving climate neutrality, a clean and circular economy, preventing desertification and land degradation, and

halting biodiversity loss. Maria Jesus Rodríguez de Sancho stressed the **crucial role of biodiversity in soil health**, contributing to ecosystem health and farmland productivity.

Addressing the audience, she discussed the ministry's involvement in various EU regulatory proposals related to climate and the environment, such as the **nature restoration regulation** and the **Carbon Removal Certification Framework Regulation**. Regarding the soil directive, she noted that dissemination began during the Spanish Presidency, and efforts are underway to advance the proposal for a policy debate in the Environmental Council in December. The directive aims to establish a robust **framework for soil monitoring across Member States**, providing a comprehensive understanding of soil health in Europe. It also offers opportunities for Member States to **collaborate in addressing soil threats**.

Maria Jesus Rodríguez de Sancho acknowledged the challenges in implementing the directive and highlighted the Mission Soil's special role in addressing concrete soil challenges involving all stakeholders. She underscored the relevance of the Mission Soil's work in facilitating understanding of soil needs and risks, particularly in **reducing land degradation and preventing erosion**. She mentioned Spain's active participation in **developing the United Nations Convention to combat desertification** and the recent approval of the **national strategy for combating desertification**, a collaborative effort involving multiple stakeholders.

Emphasising the essential nature of collaboration, Maria Jesus Rodríguez de Sancho referred to keywords such as **balance**, **co-creation**, **trade-off**, **cooperation** and **engagement**, which resonated throughout the conference and are integral to the ministry's daily work at the Ministry of Ecological Transition.

Elena Cartea González, Vice-president of Scientific and Technical Areas at the Spanish National Research Council, expressed inspiration at the gathering of participants from across Europe and beyond to collectively address common challenges in protecting soils. She extended gratitude to Kerstin Rosenow for sharing key milestones of the Mission Soil and emphasising the significance of its Manifesto. Acknowledging the great honour of hosting the event for CSIC, González conveyed her regards to all the participants who contributed to the conference's success.

Figure 24. Group picture of the participants and the speakers after the closing session

Breakout sessions

Day 1: Breakout sessions

15. Graphical recording of Day 1: Breakout sessions

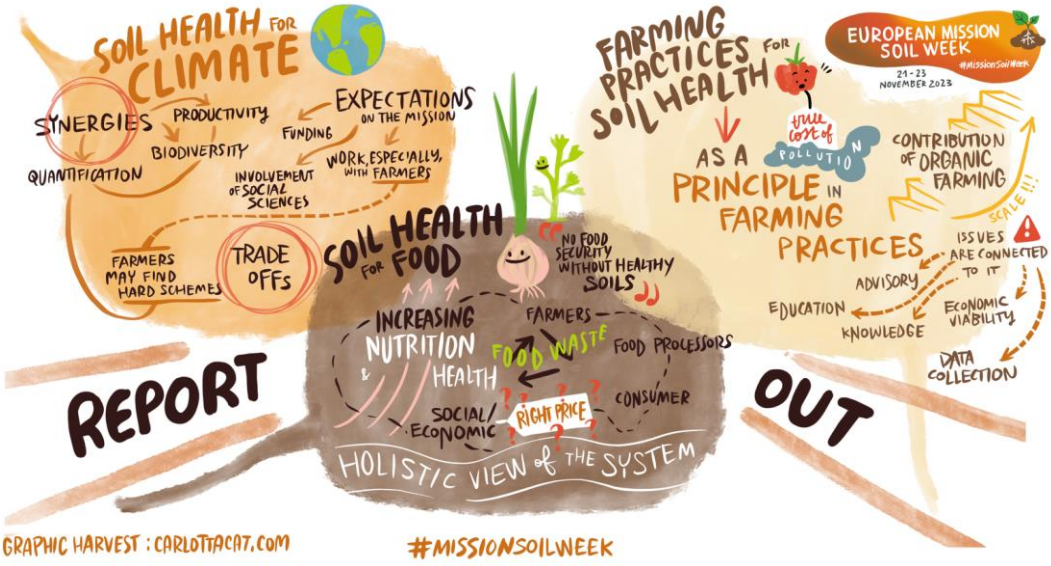

Figure 25. Graphic recording of the session 'Reporting from breakout sessions' (Day 1)

16. Breakout session 1 - Soil health for climate

Organised by DG AGRI's Research & Innovation Unit (F.2) and the EJP SOIL Programme

The session was organised by Matthias Leonhard Maier from DG AGRI's R&I Unit (F.2) and Claire Chenu of INRAE, EJP SOIL Coordinator. The objective of the session was to discuss synergies and trade-offs, identifying policy options for future EU carbon farming schemes, as well as seeking to understand the research needs in this area. Carbon farming holds a prominent position on the political agenda in the EU and Member States, serving as a potential key contribution to achieving climate neutrality. Beyond carbon sequestration and storage, healthy soils offer various essential ecosystem services. These services range from providing food, feed and fibre to cycling nutrients and other regulatory functions, as well as serving as a habitat for diverse forms of life. The session aimed to address some of the linkages – synergetic or conflictual – between carbon sequestration and other ecosystem services.

Figure 26. Speakers and moderators of the 'Soil health for climate' breakout session

16.1 Keynote speeches and presentations from speakers

Claire Chenu's presentation aimed to elucidate the contribution of soil organic matter (SOM) to soil health, underscoring that soil health represents the inherent capacity of soils to provide ecosystem services. The discussion revolved around the **effects and associated benefits of SOM**, emphasising the establishment of critical values as a pivotal framework for indicators. Four key approaches to setting these critical values were presented: fixed critical values; values relative to 'natural' land uses; values based on relative change; and values based on the distribution of the indicator values.

The presentation underscored the **importance of SOM in soil health**, highlighting its central and indispensable role, and the multiple ecosystem services it provides with inherent trade-offs. The need for quantitative information to support decision-making tools was stressed, underscoring the significance of context-specific synthesis. Chenu also pointed out the availability of **different approaches for setting critical values for SOM**, providing a comprehensive overview of the considerations involved in managing soil health.

Marta Goberna, a research scientist at INIA-CSIC, presented her findings on the trade-offs between carbon sequestration, greenhouse gas emissions and nutrient losses in the context of carbon farming. The strategy of **carbon farming involves maintaining and enhancing soil organic carbon** by reducing soil disturbance, diversifying agrosystems and increasing organic input. The presentation highlighted synergies in this approach, emphasising the positive effects of maintaining soil structure and preserving soil biodiversity. However, trade-offs were also identified, particularly in relation to greenhouse gas emissions and nutrient losses.

An increase in soil carbon was found to be associated with a significant rise in nutrient contents, with no significant increase in CO_2 emissions. Notably, the **main trade-offs** were linked to the use of organic inputs, and the study had revealed that organic fertilisers generally exhibited smaller potential trade-offs compared to chemical fertilisers. Yet, it was emphasised that not all organics behave uniformly, and better outcomes were observed when land-spreading organics were alone rather than in combination with chemicals. The presentation underscored the context-dependent nature of these practices, emphasising the large variation in trade-offs. Additionally, data gaps were identified as a hindrance to more precise model predictions, calling for a need for more information on farm

management to improve our understanding of the **complex dynamics involved in carbon farming**. In conclusion, Goberna emphasised the importance of maintaining and enhancing soil organic carbon, highlighting evident synergies with soil health, while cautioning against widespread trade-offs, especially with certain organic fertilisers, and advocating for more precise predictions through **systematic and long-term field monitoring**.

Martin Hvarregaard Thorsøe, Assistant Professor at Aarhus University, presented an in-depth analysis of existing carbon farming schemes, delving into the various types and incentives that shape these initiatives. He outlined the distinctions between activity-based carbon farming and result-based carbon farming, where the latter focuses on the outcomes of specific activities. Thorsøe discussed different design options for these schemes, including farm payments through the CAP, corporate supply chain initiatives where companies design schemes to reward farmers, and voluntary carbon markets facilitated by intermediaries offering certification. Notably, he highlighted the existence of 162 carbon farming schemes in the ORCaSa[4] web registry.

Thorsøe also explored **trade-offs and synergies within carbon farming schemes**. Some trade-offs were identified in terms of accuracy and costs in MRV, as well as perceived fairness due to local opportunities. The field-based approach to certification incurred trade-offs at both the farm and landscape scale, while the multifunctionality of schemes introduced additional costs and complexity, negatively impacting uptake. Thorsøe emphasised the importance of considering the total greenhouse gas balance and dynamic effects, along with regulation at the practice level. On the flip side, he noted that farmers were keenly interested in synergies, stressing the need for effective communication of the benefits. However, quantifying and comparing synergies within carbon farming schemes proved challenging. Thorsøe concluded with insights into the **certification of existing result-based schemes**, highlighting the need for a more comprehensive monitoring of relevant indicators, addressing short-term certification periods, and focusing on additional sequestration rather than maintaining existing carbon stocks. He also underscored the importance of a targeted and result-oriented approach to agricultural support, considering the competition between schemes and the overall policy mix. He suggested that a targeted use of activity-based schemes could complement result-based approaches, especially for multifunctional practices.

The session also included an additional presentation of a Deep Demonstration example. **Saskia Visser**, representing EIT Climate-KIC, presented a strategic framework for Ireland aimed at achieving critical 2030 targets related to climate and sustainability. This initiative is embedded within the Food Vision 2030,[5] a comprehensive plan for **Ireland to become a world leader in sustainable food systems**. The presentation highlighted the Deep Demonstration process, where 275 project ideas were distilled into seven flagships addressing both shorter and longer-term goals. Flagship 4 specifically focuses on valorising environmental services to diversify incomes through carbon farming. The need for such a framework in Ireland was evidenced by key conclusions from a dedicated workshop, emphasising the imperative to decarbonise agriculture, protect the environment, provide financial diversification for farmers, ensure food security and establish a sustainable food system. The overall objective is to support the adoption and scaling of management practices that align with Ireland's climate, biodiversity and water quality targets by 2030.

The presentation also outlined the outcomes of public consultations, indicating strong support for compensation for ecosystem services, with a suggested initiative lifespan of 20 years according to most respondents. The framework's elements, including emission reductions, carbon removals, and the co-benefits of biodiversity and

[4] https://irc-orcasa.eu/

[5] https://www.gov.ie/en/publication/c73a3-food-vision-2030-a-world-leader-in-sustainable-food-systems/

ecosystem restoration had been discussed with a clear preference for an integral approach. The majority believed that the State or the EU should bear the financial responsibility for these services. Concluding the presentation, Visser highlighted the substantial **interest and willingness to participate in carbon farming**, coupled with high expectations and a preference for an integral approach among Irish stakeholders. The integral approach had been praised for providing flexibility and enabling the realisation of multiple targets beyond carbon capture.

During the **discussion session**, Thorsøe faced questions about farmers' willingness to participate in either activity-based or result-based carbon farming schemes. His reply highlighted challenges and discontent with result-based schemes, particularly concerning the timing between the start of activities and achieving results. It was noted that activities need to be attractive for farmers and some schemes in the US accompany farmers during the transitional phase. An essential aspect raised was the importance of training and education in the MRV systems, as a lack of training makes it difficult to get farmers interested.

In response to a question directed to Goberna about the stability of organic fertilisers and the assessment of trade-offs, Goberna emphasised the consideration of climatic regions in the study, but noted a lack of sufficient measurements for trade-offs. She stressed the need for more precise measurements and acknowledged the importance of stable organic fertilisers in minimising potential trade-offs. Chenu contributed to the discussion, emphasising the need to assess the entire value chain of biomass in carbon farming schemes, considering both processing trade-offs and the overall benefits. The speakers collectively highlighted the **necessity for a comprehensive approach**, including precise measurements, considerations of the entire process, and a focus on educating and supporting farmers in adopting sustainable practices.

The session participants then reacted to a series of Slido questions, providing valuable perspectives on key aspects of carbon farming and soil health. In response to the query about the most relevant synergies for inclusion in MRV systems for carbon farming, participants emphasised biodiversity, climate change adaptation and water retention. This recognition highlights the interconnected nature of carbon sequestration with broader ecological and climate-related goals.

One question sought participants' opinions on ‘no regret’ options – practices minimising trade-offs between carbon and other greenhouse gases. The responses underscored a commitment to sustainability, with participants highlighting cover crops, plant residues, no-till farming, hedgerow planting, biochar application and agroforestry as practices that offer simultaneous benefits for carbon sequestration and overall environmental health.

Participants were then asked to recommend an approach for carbon farming schemes based on the current state of knowledge regarding synergies and trade-offs. The majority favoured a practice-based approach, reflecting a preference for rewarding specific actions taken by farmers to enhance carbon sequestration in soils. This insight emphasises the importance of incentivising on-the-ground efforts and tangible measures.

Moving beyond the presentations, participants identified additional potential synergies deserving attention, including water quality, landscape management, resilience, social considerations, socio-economic factors and rural development. This holistic perspective underscores the need for a comprehensive approach to carbon farming that addresses a diverse range of interconnected goals. In addressing potential trade-offs beyond those covered in the presentations, participants raised considerations such as yield, erosion, scalability, pollutants and the harmonisation of data. These responses highlight the complexity of implementing carbon farming practices and the necessity of assessing and mitigating potential trade-offs across various dimensions.

Lastly, participants were asked about **Mission Soil contributions towards creating synergistic carbon farming** in the EU. The responses suggested a diverse set of contributions for the Mission. Knowledge sharing, lobbying and urban agriculture are seen as valuable, along with funding support for collecting field data and the establishment of fair indicators and achievable targets. Research-related initiatives, including making research work together, Living Labs, Lighthouses, and awareness-raising, were highlighted. Several participants emphasised the importance of MRV systems, advocating for affordable MRV, best practices in MRV and involving citizens in the measurement and impact assessment processes. Long-term measurements on peat soils, particularly in underrepresented areas, were deemed essential, as well as raising awareness among decision-makers. Financial aid, funding for regions facing more challenges and the identification of new opportunities for rural development were also considered crucial. Additionally, there was a call for diverse solutions to avoid monocultures, emphasising management practices that reduce methane (CH_4) and nitrous oxide (N_2O) emissions, as well as recognising the economic value of soil health. The need for follow-up projects, business models, collaboration platforms and open exchange of data and results was highlighted, along with the importance of harmonising national policies, developing communication materials that resonate with farmers, and involving farmers and municipalities in the process. The respondents stressed the significance of an agreed-upon framework, setting best practices, providing advice to go beyond carbon farming and assessing the best agricultural practices through a bottom-up approach.

Overall, the Slido questions facilitated a rich exchange of perspectives, emphasising the **multi-faceted nature of carbon farming** and the importance of considering a wide array of factors in its implementation.

The **panel discussion** featured Christian Holzleitner, Head of Unit at the European Commission's DG CLIMA, responsible for the proposed regulatory framework for certification of carbon removals, Cristiano Ballabio from JRC, Tristano Bacchetti De Gregoris from SAE Innova (Coordinator of the CREDIBLE[6] project), and Saskia Visser of Climate-KIC. The panel, moderated by Claire Chenu, explored reactions to the presentations and audience questions.

Christian Holzleitner emphasised the need for **concrete methodologies to assess the net climate benefit** of activities like re-wetting peatlands and agroforestry. He stressed the importance of developing credible methodologies to quickly roll out scalable and operational solutions, acknowledging the urgency in achieving carbon neutrality by 2050.

Cristiano Ballabio from JRC highlighted the need to view soil beyond its role as a carbon container, emphasising the challenge in setting thresholds for diverse soil properties. Tristano Bacchetti De Gregoris of SAE Innova discussed the importance of an integral approach, combining both result-based and practice-based measures for transformative impact. Saskia Visser from Climate-KIC emphasised the necessity of setting feasible thresholds for farmers and rewarding collaboration between them.

The discussion touched on the debate between result-based and practice-based approaches, with emphasis on the transformative potential of result-based schemes. The importance of **customising solutions for different climatic regions/areas**, monitoring and addressing social contexts of farmers were highlighted.

Concerns were raised about the inclusion of organic amendments in carbon farming practices, with Holzleitner once more encouraging input on concrete methodologies. The panel emphasised the need for an integral approach,

[6] https://www.project-credible.eu/

quick implementation of scalable solutions and the importance of upscaling measures globally. The discussion also highlighted the significance of connecting different projects, avoiding duplication and providing guidance for better integration at the local and regional levels.

16.2 Conclusions and the role of the Mission Soil

The Mission Soil is making key contributions to preparing the ground for carbon farming in the EU, addressing challenges and promoting a comprehensive approach. Recognition of farmers' reluctance to engage in purely result-based carbon farming schemes emphasises the need to make activities attractive for farmers and provide support during transitional phases. Education and training in MRV systems emerged as crucial, highlighting the necessity of enhancing farmer interest through knowledge-sharing initiatives.

Discussions also focused on the stability of organic fertilisers and the assessment of trade-offs, revealing a need for more precise measurements. The Mission Soil's diverse contributions include knowledge sharing, R&I funding support and various specific research initiatives. Participants emphasised synergies e.g. with biodiversity and climate adaptation, with many expressing a preference for a practice-based approach in current carbon farming schemes.

17. Breakout session 2 - Soil health for food

Organised by DG Research and Innovation, Bioeconomy & Food Systems Unit (B.2)

The session was organised and moderated by Giulia Meloni and Giuseppe Pellegrino from DG R&I, Bioeconomy & Food Systems Unit (B.2). It revolved around the pivotal role of soils in agri-food systems, aligning with the objectives of the European Green Deal and the Farm to Fork strategy. Emphasising the link between healthy soil and food production, the discussion aimed to extend to the potential of waste valorisation as a key element in achieving a fair, healthy and environmentally friendly food systems. The Mission Soil is positioned as a driving force in enhancing soil health, improving the nutritional quality and safety of food, and increasing the valorisation of food waste for bio-based fertiliser production.

The first part of the session featured keynote presentations that set the stage, covering national examples of activities supporting soil and food production, the role of the Partnership for R&I in the Mediterranean Area (PRIMA)[7] in soil, water and food production, challenges and perspectives in soils and food systems in the Mediterranean, and commitments to nutritious food through soil health-centric land management. In the second part of the session, project coordinators presented expected outcomes from Mission-funded projects, such as the SOIL O-LIVE[8] project investigating the connection between soil health and the quality of olive oil, the DeliSoil[9] project utilising innovative technologies to convert residues into tailored soil improvers, and the Bin2Bean[10] project supporting cities in transitioning to regenerative soil systems. This session aimed to address some key questions: how the Mission Soil can enhance soil health and the nutritional quality and safety of food, ways to encourage urban individuals to optimise soil usage for local nutritious food production, and strategies for increasing the valorisation of food waste for bio-based fertiliser production, contributing to a more circular and sustainable food system.

Figure 27. Speakers and moderators of the 'Soil health for food' breakout session

[7] https://prima-med.org/
[8] https://soilolive.eu/
[9] https://delisoil.eu/
[10] https://www.bin2bean.eu/

17.1 Keynote speeches and presentations from speakers

Giulia Meloni, Policy Officer at DG R&I, started the session on the agri-food system, underscoring the pivotal roles of **Horizon Europe's Cluster 6** and **Mission Soil** as **drivers of green and digital transitions in the supply chain**. She announced the launch of a Partnership for Sustainable Food Systems[11] within this cluster in May 2024. Meloni highlighted **Food 2030**, the EU R&I's commitment to adopting a systemic approach to future-proof food systems.[12] This approach involves organising, connecting and expanding R&I efforts to provide robust evidence for effective policies and solutions. These solutions encompass knowledge, methods, technologies, services and business models, addressing four key priorities: nutrition for sustainable and healthy diets; climate-smart and environmentally sustainable food systems; circularity and resource efficiency in food systems; and the innovation and empowerment of communities.

The crucial relationship between soil health and food production within the food systems framework was emphasised, along with the **role of soils in establishing sustainable, carbon-neutral and circular value chains**. These chains are characterised by valorising resources and safeguarding **human health**. Meloni also underscored the role of soils in managing contaminants and their capacity to store and filter them. Noting that over 95 % of food production relies on soil health, she stressed the urgency of immediate action and the organisation of roundtables through cross-sector collaboration, involving the private sector to facilitate this transition and achieve these goals.

José Manuel González Vicente, the Spanish delegate to Horizon Europe Cluster 6 and Member of the Centre for Development and Industrial Technology, provided an overview of **Spain's involvement in the Mission Soil**. Since the launch of Mission Soil in 2019, Spain has been actively engaged, leveraging its experience in the bioeconomy strategy to establish effective collaborations among various national ministries, such as those for Science and Innovation, Agriculture and Ecological Transition.

The Spanish Strategic Working Group, which includes representatives from funding agencies, research agencies and Mission Board Members, focuses on implementing the Mission at the national level. In this regard, the **Mission Soil Mirror Group** plays a pivotal role in connecting academic, government and private sector entities to align initiatives and address the needs of end users, such as farmers and associations. The group discusses the Mission Soil Work Programme and provides insights into tools and Living Labs for soil health. The comprehensive list of initiatives compiled has been instrumental in supporting new soil-related projects at both the national and European levels, such as the EJP SOIL and the PREPSOIL project. The group has also identified potential sites for Living Labs, reflecting Spain's active contribution to the Mission and its commitment to soil health and sustainability. González Vicente underlined the essential need for healthy soils for healthy food and security, as well as Spain's commitment to support soil-related initiatives.

Antonella Autino, Programme Coordinator of PRIMA, discussed the partnership's role in soil, water and food production in the context of Mediterranean areas. **PRIMA**, funded by Horizon 2020 and operational from 2018 to 2027, is dedicated to **improving soil health, water management and food production**, with a particular focus on **Mediterranean regions**. It aims to address specific regional challenges, including soil conditions affected by the

[11] https://research-and-innovation.ec.europa.eu/document/download/a35be177-7024-4849-843f-c8bfa7892712_en?filename=ec_rtd_he-partnership-sustainable-food-systems-april_2022.pdf
[12] https://research-and-innovation.ec.europa.eu/research-area/environment/bioeconomy/food-systems/food-2030_en

Mediterranean climate and the critical issue of farmland desertification, which impacts a substantial portion of the region's agricultural land.

PRIMA serves as a model of science diplomacy for **some non-European regions**, notably in the Middle East and north African countries like Tunisia, Lebanon, Jordan and Egypt. The programme complements Mission Soil's focus on soil sustainability, sharing goals such as combating desertification, conservation and reducing pollution. Autino emphasised the importance of collaboration between PRIMA and Mission Soil to tackle **mutual challenges** and attain shared objectives.

EU Mission 'A Soil Deal for Europe'	PRIMA
Objective 1: reduce land degradation, including desertification and salinisation	**Land and water sustainability** PRIMA supports the adoption of agricultural practices that prevent soil erosion salinisation and the depletion of soil fertility
Objective 2: conserve and increase soil organic carbon stocks	**Smart and sustainable farming** PRIMA aims to conserve soil resources, including measures to promote the preservation and enhancement of soil organic carbon
Objective 3: no net soil sealing and increase the reuse of urban soils for urban development	-
Objective 4: reduce soil pollution and enhance restoration	**Smart and sustainable farming** PRIMA aims to reduce soil pollution and actively support the soil restoration effort
Objective 5: prevent erosion	**Cross-cutting theme: soil sustainability** PRIMA contributes to the prevention and effective management of soil erosion
Objective 6: improve soil structure to enhance habitat quality for soil biota and crops	**Smart and sustainable farming** PRIMA focuses on the preservation of suitable habitats for soil biota and crop growth
Objective 7: reduce the EU global footprint on soils	-

Table 1. Correlation between the Mission Soil's objectives and PRIMA programme

The PRIMA programme has funded several projects focusing on various soil aspects. These include reducing land degradation, conserving soil, decreasing soil erosion, improving soil structure using organic materials and providing specific solutions for farmers. In response to the emerging issue of **desertification** in northern Mediterranean countries due to climate change, the partnership plans to launch competitive calls on specific subjects to continue supporting collaborative research in sustainable agriculture, food production and water management.

Pandi Zdruli, from the Centre for Advanced Mediterranean Agronomic Studies (CIHEAM) Bari and Mission Board Member, shared further insights on the Mediterranean perspective of food and soil health. The presentation emphasised the stark **differences in income levels** and resource stability between the northern and southern

Mediterranean regions, along with urgent **challenges** like the loss of arable land, soil degradation and the significant impacts of climate change in these areas. Regarding climate change, predictions for the Mediterranean areas, indicating higher temperatures and reduced rainfall, were noted as a source of increasing regional stress. This underscores the need for the food supply chain to enhance its capacity to anticipate and adapt to these changes for sustainable food systems. The importance and necessity of promoting the **Mediterranean diet**, recognised by the United Nations Educational, Scientific and Cultural Organization (UNESCO), in moving towards sustainable food systems were also mentioned. Zdruli highlighted his involvement in various projects, working closely with local stakeholders to identify problems and explore solutions. This includes the Living Lab approach, such as Project NET, which focuses on enhancing sustainable land and water management practices to boost agricultural productivity. Additionally, he mentioned the Soil4MEP project, which involves activities like Living Labs and developing soil health indicators.

Zdruli concluded by emphasising the critical importance of meticulous soil management, particularly in southern Europe, stressing the **need to establish regional information systems** on soils for **north Africa and the Middle East**, similar to Europe's LUCAS System.

Alfred Grand, a farmer and owner of GRAND FARM in Austria, detailed the research and demonstration efforts dedicated to enhancing soil health on the farm. He emphasised the importance of **earthworms as prime indicators of healthy soil** and the significance of **soil health in yielding high-quality food**, especially with minimal pesticide residues. The essential contribution of soil microbes was instrumental in reinforcing the bond between plants and soil for more productive and resilient food cultivation and combating land degradation, and thus for sustainable agriculture. Grand talked about how the initiative for producing **vermicompost** and actively employing earthworms has greatly helped soil regeneration and mitigated soil degradation. At his farm, direct sales to consumers enhance communication and elevate consumer awareness regarding the significance of soil health. Their slogan, '**Raising food, soil, and people**,' reflects their commitment to impacting various aspects of agriculture, from food production and soil improvement to educating people, not just during the purchase but also through on-farm training.

Grand emphasised the need for a **systemic approach in formulating sector-specific solutions** to climate change. This includes transitioning from chemical to nature-based solutions, agroforestry's role and enhancing market value. He stressed the importance of engaging with consumers and citizens to re-establish their connection with the land.

Giuseppe Pellegrino opened the second part of the session focusing on practical implementations and real-world applications. He emphasised the importance of understanding the **nutritional quality** of food. While healthy and fresh vegetables may appear visually appealing, they might lack **essential micronutrients** necessary for human consumption. Pellegrino underscored the significance of using organic matter and compost to enhance soil health, thereby improving the nutritional content of the produce grown in it.

Antonio Manzaneda, Coordinator of the Soil O-LIVE project, presented the initiative's focus on researching the relationship between **soil health in European olive groves** and food health. The project started in January 2023, gathering partners across Europe and Morocco. Manzaneda's presentation highlighted a critical concern i.e. the recent decline in olive oil production, leading to the need for imports. However, it seems that the area dedicated to olive groves in Europe is on the rise, now spanning over 5 million hectares. Yet, a notable challenge remains in the regional disparities of olive production, with specific areas being more productive than others.

Manzaneda mentioned a study showing a **significant 20 % soil loss in olive groves**, caused by intense rainfall, poor grove management and soil compaction. He also emphasised the increasing **environmental concerns** associated with pesticide use, highlighting their escalated importance over the past 15 years and the urgent need for policy interventions. Additionally, it was noted that the quality of olive oil, especially its phenol content which is crucial for human health, is affected by various factors. These include soil pollution, pesticide use, water availability and antibiotic resistance, all playing a role in determining the oil's properties and health benefits.

The project uses a model to analyse the significance of various factors in determining the quality and production of olive oil, with a particular emphasis on **quality assessment tools**. The project plans to implement restoration practices in its second phase. These practices include diversifying organic methods, boosting organic carbon levels and eliminating metal contaminants. The effectiveness of these practices will be validated using key indicators, facilitating the evaluation of typical management conditions and enabling comprehensive soil monitoring.

Ansa Palojärvi, Coordinator of the DeliSoil project, presented the initiative's commitment to producing sustainable soil improvers through circular economy processes with the aim of boosting soil health. Launched in June 2023, DeliSoil, in collaboration with its 14 partners, is dedicated to demonstrating the business potential of soil health practices within the food industry. This project prioritises **environmental sustainability**, advocates for the cascading use of resources and aims for efficient material utilisation, focusing on **waste reduction and resource improvement.** These goals are pursued through strategic collaborations with biogas plants and various companies. DeliSoil capitalises on the synergy between different sectors and contract farmers, encouraging environmentally friendly practices. These practices may be recognisable through **eco-labels** for their ecological contributions. The project underscores the crucial role of soil in Europe's food security, emphasising the continent's reliance on external resources and highlighting the importance of resilient production systems and consumer engagement in promoting soil health.

With a comprehensive multi-faceted approach, DeliSoil operates experimental sites, notably in Germany, covering the entire agricultural value chain, from farming methods to the food processing industry. The project features five lighthouse initiatives, fostering collaboration on specialised techniques and nature-based processes. DeliSoil's objective is to **enhance soil health collaboratively through Living Labs**, involving stakeholders across the value chain and disseminating these practices across its network to foster regional circular economy solutions.

Sara Daniotti, Bin2Bean's **Coordinator**, presented the project, focusing on **transforming food and organic waste into soil improvers** such as compost and biogas residue. The project aims to streamline the value chain's recycling process, establish specific targets and develop an evaluation framework and scoring system for soil improvers.

Daniotti pointed out the **lack of standardised EU regulations** for soil improvers and the issues of social acceptance and product integrity. However, these improvers can enhance soil health by addressing nutrient replenishment, water retention, carbon sequestration, erosion reduction and improving biological activity. She highlighted the relevance of this approach, especially in the context of potential fertiliser shortages. The Bin2Bean project includes **three Living Labs**, each with a distinct focus. For example, the Amsterdam Living Lab aims to improve the quality of organic waste and experiment with a new collection system in a developing district, whereas the Hamburg Living Lab works on resolving the issue of residual waste contamination with organic matter and reducing impurities like plastic bags in collected waste. The Living Lab in Greece focuses on raising public awareness and implementing efficient underground collection systems.

A significant outcome of the project is the development of a comprehensive **toolbox** to assist cities in adopting these practices. This toolbox includes guidelines, tools and maps for effective biowaste recycling and soil improver production. The project also creates a decision-making system to determine the most suitable solutions based on various technical and social factors. This system will be incorporated into an app, which will recommend the most appropriate soil improvers based on specific soil needs.

The **question-and-answer session** provided a comprehensive exploration of the intricate connections between soil health, food production and human well-being. A specific emphasis was placed on the **economic challenges** faced by lower-income individuals in their pursuit of **access to healthy food**. This discussion prompted an examination of the actual cost associated with industrial-level food production and an exploration of the environmental advantages linked to small-scale agriculture. Notably, a paradox was highlighted, drawing attention to the coexistence of overnutrition in certain regions and malnutrition in others, leading to a suggestion for the adoption of healthier food systems, such as the Mediterranean diet. The recognition of the complex nature of health-related food choices, often intricately tied to income levels, underscored the multi-faceted challenges in this area.

The dialogue expanded to address the synergies among Mission Soil, ocean and climate change. Concerns were raised regarding **Europe's substantial reliance on food imports** and the imperative to decrease dependency while safeguarding soil quality. The intricate dynamics of global markets, which tend to favour the economic viability of imported products, were highlighted as contributing factors to this challenge. The conversation delved further into methods for monitoring the nutritional value of food cultivated in healthy soil, shedding light on the significant correlation between soil health, microbial presence and plant health.

The introduction of the Soil O-LIVE project brought a focus on the need for **a paradigm shift in soil restoration practices**, including innovative solutions such as seed banks. The initiative aims to collate and disseminate information on productive approaches for soil restoration to farms and cooperatives, fostering sustainable olive farming practices. Additionally, concerns were raised about the European Union's reliance on food imports and the potential environmental repercussions, particularly in terms of pollution transfer to other regions due to climate change. Acknowledging the urgency of these challenges, the discussion emphasised the necessity for fair pricing for farmers adopting sustainable methods and advocated for a systemic approach.

The session concluded with a **call for action** towards an enhanced collaboration across the food value chain **to establish a more sustainable system**. This call for collaboration suggested a shift from a consumer-centric to an environment-centric production model. Recognising the diverse needs within the food industry, proposed models aimed to shorten the value chain, actively involving consumers to raise awareness and educate industries about their environmental impact. Integral to these discussions was the consideration of waste management and reuse practices. However, it was acknowledged that while home vegetable production is a feasible solution for some, it may not be universally applicable.

17.2 Conclusions and the role of the Mission Soil

The session emphasised the necessity for continued enhancement in various areas to support a sustainable and inclusive food system. Key areas identified for improvement include biodiversity, circularity, and the challenges industries face in recycling biowaste, which could benefit soil health. Participants highlighted the significant impact of food prices on import dynamics and the absence of environmental costs in these prices. The need for pricing that reflects the quality of work, and the production process was underscored, advocating for a transformative approach

to production where all parties in the value chain are accountable for environmental impacts. This aspect is deemed crucial for coherence in future policies.

Mission Soil, as envisioned by participants, can become a dynamic force paving the way towards a sustainable and inclusive food system through a nuanced and comprehensive set of strategic approaches. At its core could lie a commitment to depollution support, recognising the imperative of soil rehabilitation and health restoration. This involves tackling environmental degradation head-on, addressing pollution concerns that have far-reaching consequences for ecosystems. The participants advocated for robust policy measures as another cornerstone, emphasising the need for regulations that not only encourage, but actively incentivise sustainable farming practices. Crafting a regulatory framework that aligns with broader goals of environmental and agricultural sustainability emerged as a critical lever for transformative change.

Direct farmer support through the CAP emerged as a tangible and impactful avenue for change. By providing financial and resource assistance to farmers embracing sustainable methods, Mission Soil not only supports individual farmers, but could also enhance the wider integration of eco-friendly practices into the agricultural landscape. Beyond financial support, the Mission could champion the 'One Health' approach, advocating for a holistic perspective that acknowledges the interconnected health of ecosystems. This forward-thinking approach recognises the symbiotic relationship between soil health, plant health and human health, positioning Mission Soil as a catalyst for systemic change.

Moreover, Mission Soil could place a strategic emphasis on active farmer engagement, knowledge dissemination, awareness-raising and the cultivation of a new generation of environmentally conscious stewards through education and training. These components collectively constitute a transformative vision that seeks to embed sustainable practices at the very core of agricultural systems. In essence, Mission Soil’s role, as outlined by the participants, emerges not merely as a singular initiative, but as a multi-faceted strategy poised to reshape the approach to agriculture, fostering resilience, productivity and eco-friendliness.

18. Breakout session 3 – Farming practices for soil health

Organised by DG AGRI's Research & Innovation Unit (F.2)

This session was organised by Susana Gaona Sáez and moderated by Luis Sánchez, from DG AGRI's R&I Unit (F.2). It explored the contribution of farming practices to maintaining, improving or re-establishing soil health while triggering the provision of other ecosystem services, together with the barriers and challenges associated to the latter.

During the session, management systems like organic farming, agroecology or agroforestry systems were analysed as prime examples where soil health restoration is achieved. The session also showcased selected EU-funded research projects and other initiatives at EU, national or regional level that are actively supporting the development of tools and innovations in this area.

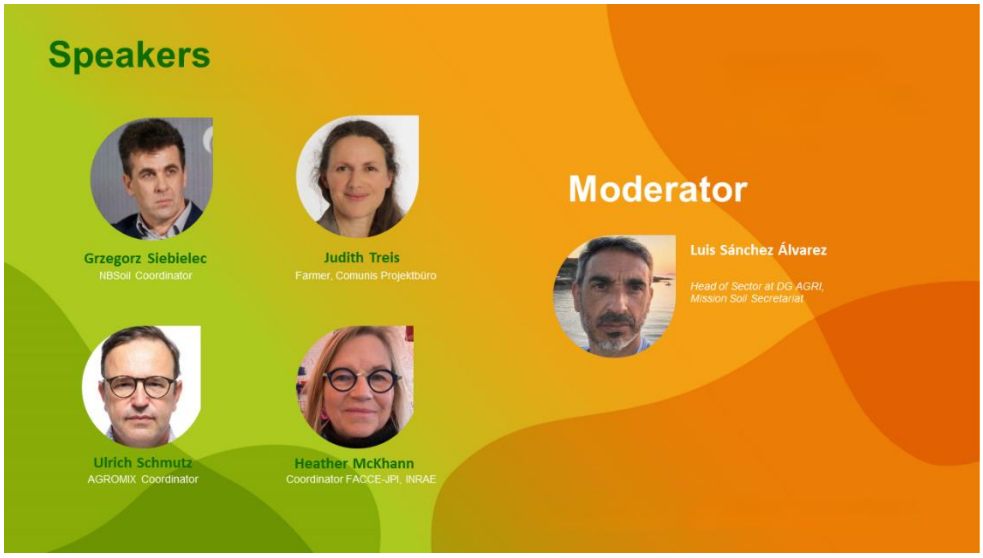

Figure 28. Speakers and moderators of the 'Farming practices for soil health' breakout session

18.1 Keynote speeches and presentations from speakers

Grzegorz Siebielec, representing the Mission Soil project NBSoil, focused on nature-based solutions for soil management. Siebielec's talk revolved around the various aspects of implementing farming practices beneficial to soil health. He emphasised that simple changes in farm management can significantly enhance soil health. He advocated for a holistic understanding of soil as a living, interconnected organism, where **improving one aspect of soil health could lead to positive effects on various other parameters**. This approach underscores the complexity and interconnectedness of soil components.

A key point of his presentation was the significance of **protecting and increasing the soil organic carbon budget through specific farming practices**. This approach can have wide-ranging positive impacts on overall soil health, influencing numerous factors and soil parameters. The benefits of maintaining or increasing SOM were highlighted, including erosion prevention, improved soil structure, enhanced water retention and pH buffering. These aspects are crucial for drought prevention, offering optimal conditions for crops in terms of stress resistance and water use

efficiency. He cited Poland's negative water balance as an example where healthy soil plays a crucial role to improve water retention and availability for crops.

Siebielec also noted the importance of **soil biodiversity as an underlying factor influencing all soil parameters**. He pointed out that farmers might not always be aware of the interconnections among these factors and that the effectiveness of regenerative farming practices can vary depending on location-specific conditions. He also mentioned that there are limitations and challenges to their implementation. For instance, intercropping and cover crops (including those used for carbon farming eco-schemes) could potentially reduce water availability for the main crops due to a competition effect.

He further discussed broader challenges in implementing farming practices beneficial for soil health, such as the need for more testing, a shift in agricultural advisory focus and the insufficient demonstration of the effects of regenerative farm practices. In response to these challenges, he proposed solutions like **establishing Living Labs and Lighthouses** for co-creation, **enhancing knowledge integration** and sharing, and **improving innovative soil advisory services**.

Siebielec concluded with an overview of the NBSoil project, its key objectives, geographical scope, different land uses and main activities. He highlighted that NBSoil would enable soil advisers to identify and recommend nature-based solutions, make use of digital tools for learning, soil monitoring, modelling and mapping, integrate and use data and models effectively, and foster collaboration among soil advisers and other experts. This will be achieved through the Soil Academy, a central output of the NBSoil project, aimed at assisting municipal administration and businesses in shifting to nature-based solutions. Other outputs of the project include a massive open online course, toolkits, GIS tools, a modelling tool, a remote sensing handbook and the NBSoil card game. The presentation ended with a call for collaboration, emphasising the potential for synergies with other Mission Soil projects.

Judith Treis, a farmer who shared her experiences from running an organic farm in Ruhlengut (Germany), has been managing the family farm organically for over 26 years, and has spent the last five years focusing on sharing and disseminating their experiences in organic farming.

In her presentation, Treis detailed the key aspects of her farm, including its location, climate and the types of crops grown. She emphasised the **critical importance of soil health in organic farming**, especially since the use of mineral fertilisers is prohibited in this type of agriculture.

Treis shared several successful soil regenerative practices employed on her farm, notably the cultivation of alfalfa grass, which has been particularly effective in enhancing soil health. She explained how alfalfa positively influences soil structure when rotated with arable crops, allowing for only light tillage due to the structuring effect on the soil already provided by the alfalfa. Additionally, this cover crop benefits soil biota and overall soil fertility, as evidenced by an increase in the earthworm population. Alfalfa also generates a substantial amount of green biomass, both above and below ground, contributing to carbon sequestration. Moreover, this biomass can also be directly used as a feed for livestock. However, if there is no livestock on the farm, the grass has no direct use, and it can compete for land with income-generating crops. One solution she proposed was combining alfalfa cultivation with biogas production, where the biogas byproduct, slurry, can be used as fertiliser. Despite the numerous benefits, Treis acknowledged that cover crops like alfalfa entail considerable costs for farmers without necessarily providing direct economic benefits. This, combined with lower yields, poses a significant challenge, as non-economic activities are not feasible for farmers. To mitigate this, Treis suggested using more cost-effective cover crops like rapeseed and mustard.

Ulrich Schmutz provided an insightful overview of the benefits and trade-offs for soil health in different management systems such as 'organic', 'agroforestry' and 'agroecology'. His insights were based on experiences gathered from three EU-funded projects: AGROMIX, Organic-PLUS and AE4EU.

Schmutz began by shedding light on the historical development of organic farming, highlighting three distinct phases. The first phase, dating back to 1924, featured records from Switzerland and Poland and was referred to as the 'twin-track' of organic farming. In 1972, the formation of the International Federation of Organic Agriculture Movements (IFOAM) and the introduction of the EU Eco Regulation 2092/1991 in 1991 marked significant milestones, leading to further standardisation of organic farming practices. He noted that by 2030, there is a target for 25 % of land in the EU to be used for organic farming, a threshold already surpassed by some countries like Austria. However, he pointed out that **the growth rate of organic agriculture in the EU is slower compared to non-EU countries** and that more ambitious targets are needed.

The Organic-PLUS project, he explained, aims to phase out contentious inputs for soil and climate health related to various agronomic practices, such as the use of glyphosate for weed control and copper, which is widely used in organic management to control fungi.

Schmutz then discussed the AGROMIX project, which focuses on participatory research to facilitate the transition to resilient and efficient land use in Europe. This project provides practical agroecological solutions for farm and land management, and explores novel approaches and technologies to promote innovation. It involves a combination of replicated trial sites, co-design pilots, study sites and stakeholder groups across Europe.

He also touched on AE4EU (Agroecology for Europe), which revolves around agroecology Living Labs and research infrastructure examples. Schmutz brought up the example of an urban Agroecological Living Lab in Coventry, which envisages the cultivation of organic fruits and vegetables in urban soils. He stressed the importance of further developing urban/per-urban agroecological Living Labs that combine organic horticulture with community food processing and waste recycling.

In his conclusions, Schmutz emphasised the systemic benefits for soil health when applying organic farming, agroforestry and agroecological management, as demonstrated by the results of these projects. He highlighted that **agroforestry management integrates the concept of 'three-dimensional farming' into organic farming**. In fact, trees in agroforestry systems reach deeper root zones, alter microclimates for wind and water availability, and can enhance functional biodiversity. He acknowledged the numerous benefits of agroforestry systems for soil health, but noted that this management scheme should be applied on a much larger scale in Europe. Additionally, he remarked on the legal regulation of organic farming, which enhances its credibility and reduces the risk of 'greenwashing' for consumers. However, he also noted that **consumers still require factual and fair information about these management systems**, along with fair cost accounting for farmers involved in them.

Heather McKhann from INRAE, presented the upcoming Horizon Europe Partnership 'Agroecology'. McKhann began by defining agroecology as the science of ecological processes applied to agricultural production systems. This approach benefits from the interplay of science, technology, and traditional or indigenous knowledge by farmers and stakeholders in value chains. She emphasised that **agroecology is seen as a promising way forward**, as reflected in numerous EU policy documents and strategies such as the Green Deal, Farm to Fork Strategy, Organic Action Plan and the CAP. Agroecology encompasses organic farming as well. McKhann continued by highlighting agroecology's potential for transformation and innovation, while stressing the need for

consideration of context and scale. She acknowledged that while there are benefits and opportunities in adopting agroecology, it also presents trade-offs and challenges.

To address these trade-offs and challenges, **the EU Partnership Agroecology initiative aims to support the agricultural sector in meeting policy targets and responding to societal challenges**. This large-scale, long-term European R&I endeavour will focus on defining problems in real-life scenarios and co-creating solutions in concert with end users and relevant actors through a Living Lab approach. In this context, research infrastructures will play a crucial role in providing support and making scientific data and knowledge available, with iterative approaches fostering innovation. The partnership aims to bring together Living Labs and research infrastructures to upscale the transition. By doing so, it will support research to better understand agrotechnological practices and how they can be combined to address the aforementioned trade-offs. This approach is designed to facilitate a deeper understanding and more effective implementation of agroecological practices across Europe.

McKhann noted that the partnership consists of 70 partners from 26 countries, pooling resources from Member States and the European Commission. It is structured around an intervention logic that includes a common vision, general and specific objectives, and defined actions. She outlined that the partnership is organised around four core themes, with the first theme aimed at redesigning agroecosystems as this is the most relevant for soil health.

During **the question-and-answer session**, the four speakers had the chance to reply to questions from the moderator and from the audience.

When inquired about the remaining gaps in research that the Mission Soil and other instruments will focus on, one of the speakers acknowledged that **there is still a gap in knowledge related to the topic of soil biodiversity**, specifically on how to measure and foster it, as well as on the specific benefits and inherent interactions of the latter with other soil properties (e.g. link between soil biodiversity and nutrient use efficiency). Filling this knowledge gap will shed light on and clarify the mechanisms through which farm practices affect soil health. Another research topic to further investigate relates to the role of sub-soil in determining soil health. The moderator reminded the audience that two Mission projects on this topic started in 2023. Finally, the necessity to ‘index’ soil health, including the weight of the various components of soil health, in a way that can be easily understood by farmers, was recalled. Linked to the definition of soil health and its components, the notion of soil-borne diseases and the need to include this aspect in the overall definition of soil health (and of a soil health index) was stressed.

Another question raised during the discussion focused on the barriers and obstacles for the scale up of organic farming and, more widely, farming practices which are beneficial for soil health. Notably, organic management is part of the wider pool of agroecological practices that are beneficial for soil health and can thus be implemented both in organic and conventional agricultural systems. Building on their direct experience as an organic farmer, one of the speakers stressed once again that the economic profitability of organic farming and the costs (also in terms of missed yield) incurred by farmers when applying regenerative soil practices should be considered. Moreover, the potential drawbacks of such farming practices will be reflected in the advisory services and in research. To this end, it was suggested **that economic impacts of soil regenerative farming practices** should be embedded in a dedicated work package in each soil research project.

The testimonials from an organic farmer during the presentations sparked the interest of participants, who asked several questions on the technicalities and agronomic practices linked to organic management, including on the strategies to control soil-borne diseases and on how to source composts and other organic fertilisers. Regarding the pest-control, it has been recalled that a direct control poses challenges in organic farming, as pesticides are not

permitted. Prevention methods such as crop rotation can be a great help to avoid them in the first place. With respect to the sourcing of organic fertilisers, such as compost, the organic farmer in the panel stated that this is a very context-specific aspect, and that in Germany they benefit from a large quantity of green biomass that is turned into compost by municipal facilities. With respect to the production of bio slurry from alfalfa, she reiterated that their role is limited to providing a partner biogas plant with the alfalfa biomass, and that the application of slurry to agricultural soils needs careful considerations with respect to the crops needs (e.g. phosphorus/nitrogen ration in the slurry posing challenges for cereals cultivation). **A mix of academic training, public state advice and practical on-the-job knowledge** is suggested as key to approaching the knowledge-intensive nature of organic management.

Furthermore, a panellist reiterated that, as there is no one-size-fits-all approach, **the Mission Soil will promote a mix of solutions, adapted to each geographical scope**. In this regard, the value of Living Labs has been recalled, specifically on their potential to allow the shift from a practice-based approach to a context-specific and location-specific approach.

The added value of the future Horizon Europe Partnership 'Agroecology' and possible synergies with the Mission Soil was also the object of discussion. To this end, McKhann recalled that the partnership is a long-term and large-scale initiative that can create a 'critical mass' which can support, in a multi-disciplinary way, short-duration initiatives struggling to achieve the intended results. Regarding the possible intersection with the Mission, the methodology of Living Labs stands as a strong common point for both endeavours. Whereas the Mission Soil aims to cover all types of soil, thus not limiting to agricultural soils, the 'Agroecology' partnership will specifically focus on the latter. Ways forward to ensure the cross-fertilisation of the two initiatives are currently under discussion, including the possibility of common capacity building, events and clusters of projects.

During an interactive session on the Slido platform, participants were prompted to contribute their insights on the challenges and gaps in promoting farming practices for soil health that have yet to be addressed by research. The identified gaps encompassed economic viability concerns, where comprehensive assessments on the profitability of soil health practices were deemed lacking. Issues with accurately assessing soil biology, including fungal-to-bacterial ratios, were also noted. Communication and knowledge transfer hurdles were highlighted, emphasising challenges in effectively conveying location-specific practices and their impact on yields. Participants also underscored the need for scalable and region-specific approaches that consider long-term economic viability and local conditions. Other identified challenges included insufficient incentives and empowerment for farmers, advisers and land managers to adopt soil health practices, difficulties in integrating traditional and academic knowledge, and the absence of adequate tools for measuring ecological impacts and scalable monitoring systems. Social and behavioural factors, such as understanding farmers' decisions, social acceptance and behavioural changes toward new practices, were also recognised as significant challenges.

To tackle these challenges efficiently, participants put forth a range of detailed solutions. These included supporting educational collaborations, soil Ambassadors and the dissemination of basic soil importance information to increase awareness. Recommendations also involved the implementation of nutritional labels, soil health certifications and clear parameters for regenerative farming practices. Engaging farmers through demonstrations, involving them in decision-making processes, and offering incentives for adopting good practices were suggested as farmer-centric approaches. Strengthening advisory services, improving communication channels and encouraging collaborative research efforts were emphasised for effective communication and collaboration. Aligning agricultural policies with soil health goals, providing market incentives and offering financial support to farmers were highlighted as critical

for policy alignment and incentives. Furthermore, recommendations encompassed enhancing extension services, promoting peer-to-peer learning, offering training programmes for farmers and advisers, and advocating for data sharing on soil health parameters while fostering participatory engagement in monitoring soil health.

18.2 Conclusions and the role of the Mission Soil

This session highlighted how adopting soil health as a guiding principle in farming involves assessing farming practice outputs and establishing robust monitoring systems, integrating soil monitoring and data collection. Organic farming stands out for its legal foundation and comprehensive management system. However, transitioning faces barriers rooted in knowledge gaps, advisory limitations and economic constraints.

Options like agroforestry, minimum tillage and no-till methods offer promise, but their context-specific nature demands consideration as they may have drawbacks such as water competition between cover crops and primary crops. Additionally, exploring the sub-soil remains an area lacking adequate understanding, posing a knowledge gap in current soil health initiatives.

The Mission Soil holds a fundamental role in advancing farming practices that are beneficial for soil. Foremost among these is the dissemination of information and collaboration, both within the research community and farmers. Financial support and streamlined communication are proposed to be amplified, aiming to ease access to funding with specialised funds designated for skill development and collaborative efforts.

Practical implementation and collaboration are envisaged through the establishment of field labs as practical research hubs, translating research into actionable policies and systematically engaging stakeholders. Farmer-centric education and raising awareness form an integral part of the Mission’s role, emphasising farmer education via peer learning, urban agriculture support and elevating soil literacy across all stakeholders.

Data management and promotion are highlighted, advocating for accessible soil databases, incentivising practitioners through restructured benefits and promoting evidence-based practices. Finally, long-term strategies and engagement stand paramount, emphasising sustained funding mechanisms, continuous citizen and farmer involvement and ongoing learning facilitated through workshops and Living Labs.

Day 2: Breakout sessions

19. Graphical recording of Day 2: Breakout sessions

Figure 29. Graphic recording of the session 'Reporting from breakout sessions' (Day 2)

20. Breakout session 4 - Soil needs in PREPSOIL regions: engaging with multiple actors

Organised by the PREPSOIL project

This session was organised by the PREPSOIL project and its objective was to inform the audience about the soil needs assessments performed by the project in regions covered by different land uses and to collect feedback from the audience for soil needs in other similar regions. Finally, it covered the activities related to stakeholder engagement within the PREPSOIL project.

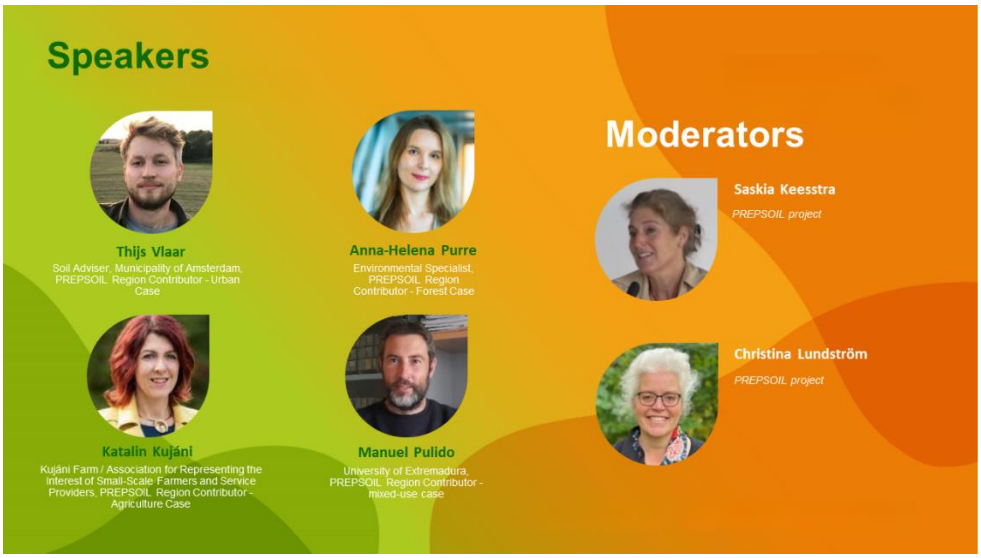

Figure 30. Speakers and moderators of the 'Soil needs in PREPSOIL regions: engaging with multiple actors' breakout session

20.1 Keynote speeches and presentations from speakers

During this breakout session, representatives from PREPSOIL offered a detailed overview of soil needs assessments in various regions, focusing on four distinct land uses as illustrated by PREPSOIL region cases.

Thijs Vlaar, a Soil Adviser for the Municipality of Amsterdam, shed light on the urban land use scenario. Vlaar set the context by sharing key facts about Amsterdam's municipality, focusing on the unique characteristics and challenges of its urban soil. He described Amsterdam as a densely populated and extensively built-up capital city of the Netherlands, marked by a mix of land uses.

The urban soil in Amsterdam faces multiple issues and impacts. A significant challenge linked to the status of soil in Amsterdam is the fact that the city's foundation lies on soft clay and peat soils, with a stable sand layer located deep below. This poses risks to building stability, leading to substantial costs. Moreover, the city is characterised by an anthropogenic topsoil layer and a considerable presence of polluted soils, a legacy of its historical and industrial past. Contaminants such as lead and perfluoroalkyl and polyfluoroalkyl substances (PFAS) are prevalent in these 'urban brownfields.' Soil degradation is a significant problem in the Municipality of Amsterdam, accelerated by high soil sealing rates and compaction, largely driven by the fast-growing urban development. A growing competition for the limited available surface and subsurface space further complicates these challenges. This degradation has led to a loss of biodiversity and increased flooding risks, further aggravated by climate change.

To tackle these issues, Vlaar emphasised several key approaches. First, **there is a pressing need to clearly define what constitutes soil health in urban contexts**, taking into account the nuances specific to different urban land uses. Another critical strategy involves prioritising soil functions for each land use within established frameworks and policies. To this end, the City of Amsterdam is in the process of developing a soil health index specifically designed for the city. Vlaar also highlighted the importance of turning abstract goals into tangible actions, especially in the current context where soil and soil health are gaining increased attention in the Netherlands and Europe. Raising awareness and forging a shared vision among citizens, urban landowners and government entities is vital, with the goal of treating soil as a shared community asset. He advocated for the **investment in Urban Living Labs,** which can significantly contribute to expanding knowledge about urban soil health – a relatively unexplored field. Such labs are crucial not only for increasing awareness, but also for fostering collaboration among different stakeholders, thus bridging the gap between government and citizens in the quest for sustainable urban soil management.

Anna-Helena Purre, an Environmental Specialist from Elige OÜ, focused on the unique soil characteristics in forest regions. She presented a detailed case study of the Soomaa region in Estonia, often referred to as the 'land of peatlands' due to its extensive coverage of peat soils, which include bogs, forests and semi-natural meadows. Purre highlighted the wildness of the area, noting that nearly half of it is under protection. Tourism stands as the primary economic activity in Soomaa, with forestry operations being relatively minor largely due to natural protection regulations that restrict such activities. A distinctive feature of this region is the 'fifth season,' a term used to describe the annual spring flooding that leaves the area submerged.

Purre discussed the various challenges to soil health in Soomaa, influenced by a range of climatic and socio-economic factors. The 'fifth season' of spring flooding, and the advent of a 'sixth season' brought about by climate change, results in winter floods that later freeze. The region also faces summer droughts and limited water availability. Historical influences, particularly the Soviet occupation, played a role in transforming semi-natural habitats into state farms, leading to a shift towards monoculture practices. Post-Soviet period efforts have focused

on the establishment of Soomaa National Park and the restoration of peatlands and semi-natural grasslands. However, Purre pointed out that while restoration is beneficial, it also brings challenges, such as the potential exacerbation of summer droughts due to the drainage of peatlands and the associated loss of carbon stock.

To tackle these challenges, Purre suggested **striking a balance between conserving nature and ensuring economic viability and human well-being**. This approach would involve safeguarding the region's wild areas while allowing for sustainable economic activities for local people, such as reconsidering restrictions on forestry operations. It is also crucial to bridge the gap between the National Park and its bordering areas, fostering consensus among the local community and authorities. Furthermore, Purre emphasised the importance of conducting extensive research in Soomaa to better understand the impacts of tourism, restoration activities and the effects of floods on this specific type of land. This research is essential for developing strategies that effectively address the unique environmental and socio-economic challenges of the region, ensuring a harmonious balance between preserving its natural beauty and supporting the livelihoods of its inhabitants.

Katalin Kujáni highlighted in her presentation the soil needs in the agricultural region of the Dong-ér Kelő-ér watershed in the Sand Ridge region of Hungary. She provided an in-depth look at the dominant land uses in the area, which primarily include agriculture field crop production (mainly arable land) and, to a lesser extent, pastures, orchards and nature conservation areas. Kujáni highlighted that the soils in this region are mainly sandy with an inherently low SOM content. The main challenges confronting this area are closely linked to climate change, including issues such as wind erosion in sandy soils, droughts and desertification all contributing to a significant loss of productivity. She noted that historically the region was covered in grass, wetlands and trees, but underwent significant changes with the increased interest in cereal cultivation, leading to the drainage of wetlands.

To address these challenges, Kujáni suggested several parallel paths for solutions. One key focus is water management in the region, which historically concentrated on draining excess water but now needs to shift towards water retention strategies through channels and ponds. Another important aspect is the application of soil conservation techniques, which includes avoiding intensive tillage, implementing regenerative techniques and carbon cropping, all tailored to the unique challenges posed by sandy soil and drought conditions. The use of cover crops and on-farm research to test and adopt regenerative farming practices in a Living Lab environment were also recommended.

Kujáni emphasised that **regions facing similar challenges should adapt these techniques to their specific contexts**, working in cooperation with local farmers by testing in real-life conditions. She pointed out that while soil conservation techniques are well-known in theory, their practical adaptation to the climatic and farming conditions of a specific region is best achieved in collaboration with local farmers, advisers and the research community. Furthermore, Kujáni underscored the importance of integrating soil management with water management. In dry, sandy regions like the Sand Ridge region, saving water and developing water retention methods are crucial. To find the best way forward, cooperation with people involved in water management is essential to devise solutions that are tailored to the specific needs of the region.

Manuel Pulido, an Associate Professor at the University of Extremadura in Spain, presented the mixed-use case of dehesa in Extremadura. Pulido began by offering an overview of the Extremadura region, noting its sparse population and the predominance of dehesa, a unique landscape that combines oak trees, annual pastures and livestock. **This mixed system is crucial for maintaining soil fertility,** especially considering that the soil in the region is generally shallow and poor in nutrients. Within the PREPSOIL project, a Living Lab is being established in

this region. Pulido described the stakeholders involved in this initiative, including academia (featuring regional researchers), farmers, cooperatives and a collaboration with the ECHO project.

He identified the main drivers that impact soil health in the region. One of the most significant is climate change, which directly affects farm profitability. Annual pastures in the region rely heavily on rainfall, and reduced precipitation caused by climate change leads to feed shortages, forcing farmers to purchase feed. Other challenges include a lack of generational renewal in the area and the loss of traditional knowledge. These factors have put considerable pressure on the dehesa lands. For example, the diminished profitability has prompted farmers to increase animal stocking rates beyond what the dehesa can sustainably support, a trend that started back in 1986.

To respond to these pressures, several solutions are proposed. Zero tillage is recommended to prevent damage to oak tree roots and wild grazing of livestock is encouraged. Another important aspect is **ensuring fair prices for the high-quality meat produced in the region**.

Pulido concluded with a message for other regions with similar characteristics. He suggested introducing livestock into agricultural systems, noting that **livestock can naturally substitute for fertilisers and pesticides**. In southern Europe, livestock can also help reduce the risk of wildfires. He emphasised the importance of efforts in labelling products, particularly in terms of animal welfare, to ensure profitability for farmers. This approach not only addresses the immediate challenges but also helps in preserving the unique agricultural landscape and practices of the dehesa.

Following the first part of the session that focused on testimonials from various land managers, Christina Lundström, the Leader of PREPSOIL Work Package 6, provided an insightful overview of the stakeholder engagement and awareness-raising activities achieved through the PREPSOIL project.

Lundström began by reminding the audience that **PREPSOIL is anchored in the eighth objective of the Mission Soil: to increase soil literacy across Member States**. The project's primary aim is to inspire and support key individuals and facilitators in their efforts to build awareness and activities promoting soil health in different sectors and areas. She explained that the stakeholders involved in PREPSOIL span three main target groups: soil advocates and communities of practice; professionals working with soil in agriculture, forestry and urban sectors; and teachers along with their pupils or students.

Lundström outlined some of the key activities within this work package. These include engaging, co-learning and co-creating with diverse organisations and ‘knowledge brokers’ within the agriculture and urban/gardening spheres. The project also focuses on developing and presenting communities of practice in Europe, where people can share methods and experiences to establish healthy soils. Another major activity is connecting soil advocates through the PREPSOIL web forum and presenting successful large-scale soil health and land restoration initiatives.

Another crucial aspect of this work package is **enhancing vocational, professional and lifelong learning in soil management**. To achieve this, surveys have been launched targeting different actors in the agriculture, forest and urban sectors to assess their understanding of soil health concepts and how they implement this knowledge in their professional roles. Investigations are also ongoing into extension programmes and grassroots initiatives concerning soil health, exploring their strengths, weaknesses and potential improvements in co-learning systems. To engage further with the PREPSOIL project, Lundström highlighted various opportunities, including two open calls in 2023 and 2024 for the Best Primary and Secondary Teaching Practices for Healthy Soils.

Lastly, as a detailed example of engaging the younger generation, she showcased the PREPSOIL feature of 'Best cases of introducing soils in primary/secondary teaching.' This was illustrated by interviewing one of the winning representatives from the 2023 call, the 'Carbon Cycle, Soil and Biodiversity' initiative from Italy. This section of her presentation underscored the importance of integrating soil health education into early and secondary education, highlighting successful efforts in this area.

For each of the four cases presented in the pitches, participants were asked, through **Slido interaction**, to validate PREPSOIL findings and provide additional input for the roadmap.

Regarding the urban case presented by Vlaar, 60 % of participants strongly agree that **there is no uniform definition of soil health in urban areas**. Participants proposed concrete solutions for urban areas, emphasising the need for comprehensive strategies. These included implementing soil quality assessments, conducting community-wide monitoring and establishing accessible soil monitoring programmes. Furthermore, participants advocated for increased community engagement and participation, suggesting involvement of citizens and practitioners in decision-making processes, participatory research and action, and community-building initiatives for urban gardening. Nature-based solutions were underscored, focusing on strategies such as revegetation, urban agriculture, phyto-regeneration and innovative soil engineering to regenerate and enhance soil quality. Participants also highlighted the importance of de-sealing and greening urban spaces, re-thinking land use to reduce sealed surfaces and incorporating more public green spaces. Additionally, there was a call to promote circular economy practices, including circular waste management, participatory processes and enhanced soil education through school projects to foster sustainability in urban areas.

For the forestry case presented by Purre, most participants share the need for **balancing nature protection and climate benefits with forestry management and economic activities**, such as timber production. The participants suggested a diverse set of solutions aimed at enhancing the health and sustainability of forest ecosystems. Proposals included rewilding and renaturation efforts to restore natural habitats and biodiversity, prioritising the preservation of high biodiversity zones and pristine forest areas. Sustainable forest management practices such as continuous cover forestry, coppicing and diversified land use were recommended to maintain ecosystem health and resilience. Participants advocated for increased awareness and education, emphasising the importance of public understanding of forests, promotion of traditional forest management practices and education about the benefits of rewilding initiatives for ecosystem health. The integration of local communities in decision-making processes through participatory policies and co-design strategies was highlighted, ensuring their active involvement and a sense of ownership in forest management. Additionally, participants suggested fostering eco-tourism activities to encourage appreciation and understanding of forests, along with efforts to revive and preserve cultural traditions linked to forest management as part of cultural heritage conservation initiatives.

With respect to the agricultural case presented by Kujáni, most participants agree that **an open mindset and experiments are needed to find ways to adapt to the rapidly changing environment of farmlands**. Several solutions were suggested for agricultural land use, including the promotion of crop diversification, multi-cropping and the integration of minor crops, legumes and intercropping. Soil improvement through fertilisers and bio-stimulants was encouraged, fostering the use of biochar, organic amendments, bio-stimulants (e.g. mycorrhiza) and other methods to enhance soil health and biodiversity. Water management strategies involved the development of ponds, swales and constructed wetlands for rainwater recovery, with the aim of promoting efficient water use. Livestock integration was recommended, with the implementation of grazing systems to enhance soil health and

ecosystem function. Additionally, there was a call to increase citizen involvement, promote eco-tourism, and provide advisory services and financial support for sustainable practices to raise awareness and support for these initiatives.

For the mixed-land use case presented by Pulido, the participants strongly agreed on the **value of labelling products** (e.g. labelling schemes linked to animal welfare or the provision of ecosystem services) **as a key strategy**. For this land use, participants provided a wide range of solutions aiming to create a balanced and diverse land use approach, where livestock plays a crucial role alongside various economic activities, ensuring sustainability and community involvement in decision-making.

Participants were inquired about hindrances and bottlenecks to improving soil health at the societal level. The main inputs highlighted the following.

- Lack of awareness and knowledge: Many participants highlighted the pervasive lack of understanding about the importance of soil health, the consequences of poor soil health and the essential role soil plays in ecosystems. This includes deficiencies in education systems, societal disconnection from nature and inadequate soil science communication.
- Socio-economic and political factors: Economic interests, particularly within the framework of agriculture, sometimes emphasise short-term gains over long-term soil health. While policies and legislation aim to balance various needs and interests, there might be a need for better alignment between economic drivers and environmental sustainability. This includes exploring ways to incentivise sustainable soil management practices within the economic framework and ensuring that policies encourage and support regenerative agricultural practices.
- Engagement and perception: Public perception and engagement towards soil health remain low. Soil is often perceived as ‘invisible’ or not considered as crucial as other environmental aspects. Lack of interest, awareness, and a disconnect between stakeholders, including citizens, policymakers and farmers, also hinder improvements in soil health.

To tackle these challenges, participants suggested, among other things, leveraging social media and videos, actively participating in educational initiatives, prioritising environmental concerns, training educators and providing educational materials in local languages. They also encourage the incorporation of soil-related topics in school curricula and ensuring coherence in public speeches. Advocating for legislative changes in land ownership was also highlighted.

20.2 Conclusions and the role of the Mission Soil

Building on the work of PREPSOIL, the session highlights numerous challenges and proposed solutions specific to certain land uses: urban, forestry, agricultural and mixed-land use. In this context, the Mission Soil is expected to evolve as a driving force in raising awareness, educating and fostering collaborative actions at the EU level to ensure the sustainable management and preservation of soil health across different land uses. Overall, the Mission Soil will support capacity building, research and community engagement initiatives tailored to each land use, thereby promoting sustainable soil management practices and preserving ecosystem services in the different land uses.

21. Breakout session 5 - Knowledge transfer to farmers' advisers

Organised by the EJP SOIL programme

The session, organised by the EJP SOIL, a programme aiming to build a sustainable European integrated research community on agricultural soils, is moderated by Anna Besse-Lototskaya and Dr Amanda Matson from Wageningen University. During the presentation the pivotal role of farm advisers in disseminating and promoting innovative soil management practices was highlighted. These advisers also play a crucial role in R&I processes for successful knowledge transfer. The session encompassed various aspects, including approaches to transferring knowledge to farm advisers and addressing challenges of dissemination activities. It aimed to align activities across the Mission Soil and other European projects. It also provided insights into the current state of research specific to farm advisers and gathered input from stakeholders on knowledge gaps, success stories and opportunities for improvement.

Figure 31. Speakers and moderators of the 'Knowledge transfer to farmers' advisers' breakout session

21.1 Keynote speeches and presentations from speakers

Anna Besse-Lototskaya, Co-Coordinator of the EJP SOIL programme, highlighted the **crucial role of farm advisers in knowledge transfer**. She outlined the session's objective to explore the identities and needs of farm advisers, fostering alignment among research projects focused on this group. Emphasising the local nature of farm advisers' knowledge needs, she stressed the importance of addressing their unique questions and requirements.

Regarding the session's vision and the knowledge transfer processes to farm advisers, **Dr Amanda Matson** explained that it would commence with insights from the advisory community. The session would then feature presentations from four EU-funded projects, each providing a distinct perspective on farm advisers. To illustrate project alignment, the concept of a '**knowledge landscape**' was introduced, categorising projects based on knowledge domains and specific content sectors. This categorisation aimed to help participants understand the collective efforts of the projects in meeting the diverse needs of farm advisers.

Luis Orcaray, a Farm Adviser from the Navarro Institute of Agri-Food Technologies and Infrastructures (**INTIA**), highlighted the **challenges in farm (soil) advisory services** and knowledge transfer. He provided insights into INTIA, a public company under the Government of Navarra in Spain, which employs 43 advisers serving approximately 11 400 farmers and cooperatives. Their activities encompass numerous trials, projects and training sessions. He discussed the three main **types of advisory service** providers in Europe: public; private; and farmer-based organisations, with variations in prevalence across regions. He outlined the qualifications of advisers in Spain, emphasising their expertise in integrated pest management and fertilisation. He then delved into the expectations of soil advisers from researchers, outlining various topics of interest such as economic studies of soil management, real-time nutrient sensors and the impact of green fertilisers.

The **necessity for strategic knowledge transfer materials** has been emphasised, encompassing locations for testing soil management strategies, videos illustrating success stories and practical guides for soil fertility measurement. Additionally, there is an emphasis on advisers receiving training in soft skills and holistic approaches to soil management. There is also a focus on methodologies for facilitating farmer groups.

Dr Amanda Matson highlighted EJP SOIL's various work packages, their interconnections and collective efforts to generate valuable results. She outlined how they aim to support these projects by **providing pertinent knowledge for farm advisers**. She provided insights into findings from two EJP SOIL surveys, which aimed to prioritise different soil topics.

The first survey, involving multiple stakeholders, indicated a keen interest in greenhouse gas emissions. In contrast, the second adviser-centric survey highlighted soil compaction and biodiversity as top priorities. Understanding these priorities is crucial for EJP SOIL, as they shape the knowledge provided to farm advisers.

To deepen this understanding, a survey was conducted in 22 countries, followed by an online workshop with experts from 15 countries. These activities provided insights into varying national priorities. The findings were then presented at EJP SOIL's annual science days in Riga, where project participants were asked to align their outputs with advisers' knowledge needs, fostering effective knowledge transfer.

EJP SOIL's role in bridging soil science and agriculture was emphasised, particularly in creating and sharing knowledge objects (e.g. images, maps, publications, datasets) relevant to advisers. Phase 1 of their strategy involved identifying knowledge gaps and potential outputs from EJP SOIL projects. The current Phase 2 focuses on co-creating guidelines for knowledge transfer, using insights gathered about advisers' needs. A planned Phase 3 will build a comprehensive knowledge base for soil stewardship, linking adviser-specific knowledge from EJP SOIL projects and collaborating with the Horizon Europe EU-FarmBook to disseminate these knowledge objects widely.

Javier Montellano Lopez, from NBSoil[13] presented the project's aim of exploring and implementing **nature-based solutions for soil management**. These solutions encompass organic fertilisers, cover crops, bioremediation and blue-green infrastructure. The project seeks to **develop learning pathways** for 300 current and future soil advisers, primarily in agriculture.

A significant aspect of NBSoil is its partnership with the International Union for Conservation of Nature, emphasising nature-based solutions. This partnership involves exploring overlaps with approaches like permaculture and

[13] https://nbsoil.eu/

regenerative agriculture, addressing sustainability indicators across various environments, including urban settings. Additionally, the project aligns with agricultural targets, such as the goals of the Nature Restoration Law.

NBSoil spans various sectors, employing nature-based solutions and emphasising the importance of collaborative work among projects. Montellano highlighted the project's structure, consortium, and diverse partnerships, including NGOs like the Soil Association. Despite its primary focus on agriculture, NBSoil also considers other sectors like forestry, and urban and industrial areas, where roles such as remediation experts and urban agriculturists are emerging.

Maria Mendonça and **Diogo Moniz** from Consulai, a consulting firm in Portugal that focuses on agricultural, food and forestry sectors, showcased the ClimateSmartAdvisors project, emphasising the pivotal role of **advisers in promoting climate-smart innovations** in agriculture. This initiative complements the Climate Farm Demo project, both aimed at fostering a climate-smart transition in agriculture. Climate Farm Demo supports farmers, while ClimateSmartAdvisors strengthens advisers' capacities to offer specialised advice.

The presentation highlighted the crucial function of farm advisers, serving as a bridge between theoretical knowledge from diverse sources (policy, research, NGOs) and practical applications on farms. Advisers blend deep theoretical understanding with practical know-how, facilitating the implementation of best practices and feedback collection from the field. Various **knowledge acquisition strategies** within the project were detailed.

The **top-down approach** focuses on imparting new knowledge and techniques through structured training, enabling advisers to simplify complex concepts for farmers. The **peer-to-peer approach** centres on shared learning and community discussions, with advisers fostering collaborative environments. The **bottom-up approach** takes a practical, hands-on approach, narrowing the operational gap from theory to practice, where advisers guide farmers in applying theoretical insights. Lastly, the **multi-actor approach** involves co-creating and testing solutions in natural settings, with advisers playing a pivotal role in coordinating multi-stakeholder interactions and integrating theoretical and practical knowledge.

They stressed that no single approach is universally applicable; each must be tailored to specific goals and audiences. Advisers' involvement is critical due to their capacity to adapt to different groups, and initiatives like ClimateSmartAdvisors are instrumental in driving innovation and effective knowledge transfer within the agricultural sector.

Juan Pedro Romero Trueba, coordinator of the EU-FarmBook[14] project, emphasised the necessity of disseminating and communicating results in Horizon and EIP-Agri projects, especially when a project ends, often leading to a halt in knowledge transfer. To address this, he introduced the EU-FarmBook project, which is being developed as an **online platform** to consolidate and disseminate outcomes from these projects, enhancing their practical application and impact.

The EU-FarmBook, involving 29 partners across 18 countries, is a seven-year initiative from 2022 to 2029. Its goal is to create a **repository** that brings together knowledge from **European projects in easily accessible formats**, including images, datasets, videos, documents and software. The platform will support multiple European languages and offer features like free maintenance, open access, dedicated domain and easy upload processes while respecting authors' rights. Focused on meeting the needs of advisers, farmers, foresters and other rural

[14] https://welcome.eufarmbook.eu/

actors, the platform will host practice-oriented materials adhering to FAIR Data Principles. It aims to be a reference point for these stakeholders, providing valuable resources and information.

Consortium partners will promote the EU-FarmBook within their networks, extending its reach to national and regional levels. End users, including advisers, consultants, trainers and journalists, will access and utilise its contents directly. An **AI system**, Chatbot FarmBuddy, will be integrated to facilitate the querying of content and provide specific answers. This places the EU-FarmBook at the forefront of consolidating agricultural knowledge, covering various sectors, including soil and climate issues.

During the **discussion session**, participants actively engaged with the presented topics. Following the presentation on farm advisers, the discourse centred on bridging the gap between project outputs and farm advisers. Key themes included the crucial role of advisers, their ongoing need for self-education, and the importance of **establishing robust connections with research and advisory institutions**. Emphasis was placed on workshops and university involvement as vital components for enhancing advisers' knowledge and facilitating effective knowledge transfer.

The presentation on the NBSoil project spurred discussions on the **definition and ecological relevance of nature-based solutions**. Clarifications were made regarding these solutions as methods addressing societal challenges through ecosystem protection and restoration. The conversation underscored the need to balance environmental, economic, social and political factors within these solutions, with a specific mention of the inclusion of versatile bioremediation techniques in the project.

The presentation on the ClimateSmartAdvisors project prompted a focus on **integrating the multi-actor approach with other methodologies**. The discussion highlighted how this approach fosters interaction among industries, farmers and research institutions, forming an integral part of their overall strategies. The discussion on the EU-FarmBook platform introduced the idea of implementing a scoring system to ensure information quality. This response addressed a participant's query and highlighted the platform's commitment to providing reliable and high-quality information for users.

Throughout the session, participants actively participated in a reflective exercise, offering insights across various presentations. Discussions focused on the impact of the Soil Monitoring Directive on farm advisers, stressing the **need for a holistic approach to adequately prepare advisers**. The importance of soil biology awareness, harmonised soil data access, standardised monitoring methodologies and comprehensive training programmes emerged as crucial components in navigating legislative requirements and aiding soil monitoring. The discourse also explored knowledge transfer gaps and proposed solutions, emphasising enhanced communication, collaboration, trust-building and the integration of place-based knowledge and agroecological practices. Preferred knowledge exchange methods, such as peer-to-peer and multi-actor approaches, were identified, along with a strong preference for digital means when accessing information, emphasising user-friendly, interactive resources. The desire to consolidate platforms into a centralised resource for easier access and verification resonated among participants.

21.2 Conclusions and the role of the Mission Soil

The session highlighted a comprehensive approach to aiding farm advisers, emphasising the integration of economic, technological and environmental strategies to promote sustainable agriculture. The pivotal role of farm advisers in imparting agricultural knowledge tailored to the diverse needs of farming communities was a key focus.

Discussions revolved around the challenges in advisory services and the importance of strategic knowledge transfer methods. Topics such as incorporating economic insights, cutting-edge technologies and environmentally-practices were central to the dialogue.

The need to align various support initiatives with farm advisers' unique requirements for effective knowledge sharing was underscored. The session also highlighted the significance of collaborative work and the adoption of nature-based solutions in different agricultural sectors.

The session revealed a keen interest in knowledge transfer to farm advisers and knowledge transfer practices more broadly. Participants discussed how the Mission Soil could improve knowledge transfer to farm advisers, focusing on refining the structure and approach of projects for practical impact. The consensus called for a more integrated, practical and technologically advanced system, underlining the necessity of direct farm adviser involvement and access to centralised information sources.

The key recommendations arising from the discussion encompass a comprehensive strategy to elevate the effectiveness of farm advisers and enhance the knowledge transfer landscape. One crucial suggestion is the enhanced involvement of advisers, emphasising their active engagement as essential project partners. Recognising the critical role advisers play in implementation and communication, this recommendation seeks to establish a collaborative framework that leverages their expertise. Complementary to this, the proposal for training and education underscores the need for specialised modules based on R&I findings. It goes further to suggest the potential creation of specialised degree programmes tailored to equip farm advisers with the latest insights and tools, aligning education closely with the dynamic needs of advisory roles.

Another vital recommendation revolves around centralising information to streamline accessibility and reduce duplication. The proposition includes the establishment of a centralised, potentially multilingual knowledge repository. Coordinating knowledge platforms, such as the EU-FarmBook, is envisioned as a strategy to consolidate resources and facilitate efficient dissemination. Additionally, the integration of technology and AI tools stands out as a forward-looking recommendation. It advocates for the adoption of AI to augment personal farm advising and underscores the importance of training advisers to proficiently utilise these technologies. These technological interventions are poised to revolutionise the advisory landscape, fostering efficiency and precision in knowledge dissemination. Collectively, these recommendations aim to fortify the knowledge transfer ecosystem, ensuring that farm advisers are equipped with the necessary tools, education and collaborative frameworks to navigate the evolving agricultural landscape effectively.

22. Breakout session 6 - Living Labs and other experiences from placed-based innovation

Organised by DG AGRI's Research & Innovation Unit (F.2) and the Mission Board

The session was organised by Jelena Vidovic from DG AGRI's Research & Innovation Unit (F.2) and the Mission Board Member Muriel Mambrini-Doudet, and moderated by Rachel Creamer, Professor at Wageningen University, and Fabio Volkmann, EU Multi-Stakeholder Process Coordinator at Climate Farmers. The session highlighted a fundamental approach for integrating and sharing knowledge, with practical application to improve soil health, especially in agriculture and urban areas. It included discussions on the Living Labs concept, detailing how Mission Soil utilises Living Labs to address soil health challenges, and updates on their current implementation status under the Mission. It also featured demonstrations of existing initiatives embodying Living Lab principles, underscoring their effectiveness in tackling practical challenges.

Figure 32. Speakers and moderators of the 'Living Labs and other experiences from placed-based innovation' breakout session

22.1 Keynote speeches and presentations from speakers

Fabio Volkmann and Rachel Cramer opened the session by providing an overview of the various stakeholders in the soil system, including farmers, researchers, policymakers and citizens. They emphasised the importance of **co-creation in developing innovative and practical solutions for improving soil health** across Europe. Healthier soils result from acquiring and implementing new methods in the field, a process bolstered by interactions among farmers and community members. Additionally, effective solutions should develop at the grassroots level, starting from the soil, farms and fields, rather than being dictated by top-down policies. The Mission Soil, primarily through developing and implementing **Living Labs**, was identified as a key instrument in achieving this collaborative and ground-up approach to soil health and sustainable agricultural practices.

Muriel Mambrini-Doudet, Director of Research and Programme Evaluation at the French Research Institute for Development (IRD) and a Member of the Mission Soil Board, elucidated the **concept of Living Labs**, showcasing

examples and their activities beyond the EU. She emphasised that enhancing soil health requires accelerating the transition towards sustainable practices and promoting transformational change. In this context, she highlighted the **fundamental role of Living Labs in improving soil health**, referred to the **Mission Soil Manifesto**, and stressed the imperative to protect and restore soils as an essential source of life.

The outcomes from bibliographic analyses of Living Labs were presented, highlighting their role in bringing about innovation, efficiency and behavioural transformation. Living Labs are acknowledged as accelerators of transition, characterised by their aims, context, activities and extent, converging towards resilience and sustainability. The Living Lab approach combines awareness-raising and soil literacy with co-creation, involving users and real-time processes across all land uses, aiming to expedite transition and transformation. Emphasising the importance of tradition and reality, she noted that understanding and integrating human values into land use is crucial for implementing new processes.

She advocated for a **new economic model** that develops and combines networking activities at various levels to support this transformation, emphasising the importance of networking, sharing practices and learning from successes and failures. The Mission Board has identified the following success factors for R&I projects: building awareness; engaging society; facilitating cooperation activities; aligning with the policy framework; and considering social, cultural and economic needs. She concluded the presentation by citing successful Living Lab implementations in significant sectors such as technology, health and urban development, exemplified by cases in Canada.

Jelena Vidovic from DG AGRI, discussed **Living Labs under the Mission Soil**, explaining their implementation, benefits and expected outcomes. She clarified how the Mission Soil supports various European Green Deal strategies and policies, including the proposed Soil Monitoring Law, and is mobilising additional funding from different sources.

The Mission's primary goal is to **establish 100 Living Labs and Lighthouses by 2030**. These will lead the transition to healthy soils and are overseen by the Mission as user-centred and transdisciplinary initiatives. They bring together various actors to co-create and test solutions in real-life conditions, aiming to improve soil health and promote sustainable practices. These labs are designed to **solve soil health challenges** and **contribute to specific Mission Objectives** through four building blocks: research innovation, Living Labs for co-creating solutions, soil monitoring and soil literacy with citizen engagement.

The expected outcomes of the Living Labs include improved awareness of soil health challenges, uptake of innovative solutions, measurable improvements in soil health, increased social capital and enhanced citizen awareness.

The Mission Soil will cluster several Living Labs covering different EU Member States and experimental sites. These labs will demonstrate **good practices in sustainable soil management** and **offer practical tools** for farmers and advisers. The objective is to achieve balanced coverage of countries, regions and land use types, with the involvement of practitioners, land managers, and small and medium-sized enterprises, to accelerate sustainable management practices and the green transition.

The network of Living Labs across Europe will cover major pedo-climatic areas and land uses. Their implementation involves a phased approach, starting with preparatory actions and expanding through more extensive calls, aiming for sustainability beyond the Mission's timeframe. The presentation concluded by introducing several projects

already contributing to the creation and implementation of Living Labs. These include projects such as PREPSOIL, which focuses on tools for knowledge exchange, stakeholder mobilisation and identifying regional soil health needs, and soil health projects that assist Living Labs in harmonising approaches and enhancing experience exchange.

Dolinda Cavallo, from the European Network of Certified Living Labs[15] (ENOLL) and the Mission-funded project Startup of the Support Structure for SOIL Living Labs[16] (SOILL), provided an overview of the support activities for Living Labs within the project. ENOLL aims to **promote and enhance Living Labs**, focusing on **open innovation ecosystems in real-life environments**. Currently, it has 160 members across five continents and has certified 600 Living Labs, including those focusing on soil management, such as the Discovery Centre in Hungary and Agrotopia in Belgium.

The support for implementing Living Labs takes place through services like certification, capacity building, and training for organisations and professionals. Its **working groups**, particularly one on agriculture and rural development, facilitate knowledge exchange and collaboration. ENOLL also conducts an annual quality evaluation to ensure Living Labs maintain a consistent approach and high standards.

The organisation aligns with Mission Soil's criteria, promoting open innovation, co-creation and a real-life approach. Under the Mission Soil, ENOLL is supporting the setup and monitoring of 100 Living Labs. The first project, Soil Startup, launching in January 2024, aims to co-create and design activities with the funded Living Labs. ENOLL's 2025 activities will include providing updated information, capacity building, mentoring and engaging the broader soil community in collaborative synergies. These efforts will support the soil health Living Labs and Lighthouses, offering tools, training and collaboration opportunities.

The moderators then opened the **second part of the session**, highlighting the practical experiences of the front-row speakers. These speakers exemplify projects actively **implementing solutions**, embodying the Living Lab concepts. Their presentations showcased the power of co-creation, participation and collaboration among various actors in developing practical solutions.

Antonio Manzaneda, Coordinator of the Soil O-LIVE project, discussed the project's focus on soil biodiversity and functionality in **Mediterranean olive groves**, aligning with the attributes and expectations of Living Labs. The project, started in January 2023, includes academic partners, key stakeholders like companies and cooperatives, and significant industry players like a major oil company, supported by the International Olive Oil Council, and the JRC of the European Commission.

Olive oil is crucial to the Mediterranean diet and southern Europe's economy and social fabric, with most European production organised in cooperatives. However, there are environmental concerns regarding soil health in olive oil production, with an annual loss of significant amounts of soil and fertility across the EU. The project aims to diagnose the environmental situation in Europe's olive groves and aims to study the relationship between **soil health and olive oil quality**. Its goals include analysing the **impact of pollution and degradation** on soil biodiversity and function, investigating the correlation between soil health and olive oil quality, implementing soil amendments and **restoration practices to enhance soil biodiversity**, and defining a framework for better procedures and regulations.

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[15] https://enoll.org/

[16] https://www.soill2030.eu/

Soil O-LIVE[17] will provide a framework for future Living Lab applications, demonstrating the improvement of soil health through restoration practices and the **positive impact on olive oil quality and safety**. The project has selected 52 case studies across Mediterranean countries like Spain, Portugal and Italy to develop key performance indicators linking soil health with food quality. The presentation concluded with an outline of the structure of a future Living Lab.

Judit Berényi Üveges presented the ÖMKi On-Farm Living Laboratory,[18] **Hungary's first research network based on farmer participation**, established in 2012. This network conducts innovative experiments on Hungarian organic farms, focusing on practical, farmer-driven research topics including crop diversification, soil techniques in organic farming, precision farming and nutrient management.

They address issues such as soil degradation and sustainable growing media, particularly avoiding fertilisers due to Hungary's legal protection of peatlands. The research process involves close collaboration with farmers, from defining research questions through workshops. Experiments are set up in manageable ways for farmers, who then collect data for analysis. The results are shared through open-access scientific publications, agricultural journals and field days for broader farmer engagement.

Achievements of the ÖMKi Living Lab include introducing landrace tomato varieties and developing grapevine climbers. A vital advantage of this Living Lab is its **direct relationship between farmers and researchers**, offering practical solutions to participants and potentially benefiting a wider farming community. One challenge faced is managing research funded by one party when farmers have specific requirements for setting up experiments. While this collaborative research approach requires more effort from the scientific community, it yields valuable insights from natural farm environments, enhancing farmers' decision-making regarding soil management.

Christophe Schwartz, Professor at Université de Lorraine and Director of the Department of Soil and Environmental Sciences at INRAE, discussed the issue of **soil de-sealing in Lorraine (France),** emphasising the need for more knowledge and practical approaches to **restore healthy soils in urban areas**. He proposed using a Living Lab approach, which could be scaled up across Europe, to address the increasing problem of soil sealing due to urban density and the need for fertile soils in cities.

The focus was on understanding the consequences of leaving soils sealed, including potential contamination and impacts on carbon storage, and finding ways to maximise resilience, particularly in response to climate change.

He highlighted the **scarcity of scientific studies on soil de-sealing**, with most experience coming from companies and land planners rather than research. He presented examples of national de-sealing projects, such as ‘desert’, which aim to establish methodological frameworks for studying soils, defining soil profile representativeness and proposing indicators for stakeholder discussions. These projects also demonstrate the feasibility of converting sealed soils back to a multifunctional state, with future land use decisions made by local authorities and stakeholders.

Part of the work involves **collaborating with various partners**, including research units from **multiple disciplines**, private companies, landscape planners and public works, to create a technical guide for de-sealing design. This approach aligns with the Living Lab methodology and includes interactions with citizens to understand their activities

[17] https://soilolive.eu/
[18] https://biokutatas.hu/en/page/show/omki-on-farm-living-lab

and needs. He stressed the importance of making all stakeholders aware of the benefits of de-sealing and learning from experiences. A survey across France and abroad gathered feedback from over 60 projects, leading to field experiments and developing a guide for urban soil de-sealing operations. This initiative reflects the collaborative and multi-disciplinary nature of tackling urban soil challenges.

John Gilliland, farmer, former Mission Board member, involved with Living Labs and Place-Based Innovation in Ireland, discussed the 'Lands at Dowth,'[19] a UNESCO World Heritage Site operated by Devenish. This project, which began in 2012, focuses on **producing low-carbon beef and lamb**, aiming to empower farmers to make informed decisions by providing detailed knowledge about their emissions and carbon stocks.

Devenish's **approach integrates various stakeholders**, including a network of farmers, and is seen as a key driver in research dedicated to climate-smart farming and soil health. This involves using **advanced technologies** like detailed aerial scans for precise data collection, enabling comprehensive soil carbon analysis to depths beyond 30 centimetres. The analysis examines soil health concerning plant diversity and carbon storage.

Unlike traditional models that offer rough approximations, Devenish's approach involves detailed life cycle assessments and using light detection and ranging (Lidar) technology to measure carbon stocks in soil and vegetation accurately. This approach has revealed that a significant portion of carbon is stored in the soil, even on tree-rich farms. In addition to carbon measurement, the project **addresses water quality issues in Ireland**, particularly runoff from agricultural land. By combining data from various sources, they create runoff risk maps to identify critical areas and implement strategies to mitigate adverse impacts on water quality. This includes using multi-species swards in high-risk runoff areas, owing to their deeper roots and improved water porosity, thus enhancing soil health and reducing water pollution. He emphasised that knowledge is crucial to behavioural change. The project disseminates its findings through articles, farm walks, presentations and policy engagement. This comprehensive approach has led Northern Ireland to implement a scheme to measure every field, tree and hedge in the country, providing farmers with valuable data to inform their practices.

During the **question-and-answer session** that followed the initial presentations, participants engaged in a thorough exploration of key themes, with a particular focus on the integration of individualistic projects to enhance their relevance across Europe. Panellists emphasised the intricate nature of this process, proposing the **formation of working groups as an initial step towards harmonisation**. Cooperation and respect for regional differences were underscored, with a specific emphasis on drawing insights from the experiences of Living Labs to facilitate a more unified approach. The discussion also touched upon the topic of **certification for Living Labs** and its potential impact on participation in the Mission Soil Living Labs. The consensus emerged that while certification is not obligatory for application, the greater significance lies in becoming a network member and actively sharing experiences to foster collaboration.

Queries about the application process for Living Labs sought clarification on striking a **balance between research priorities and budgeting**. DG AGRI provided valuable guidance, allowing flexibility in indicating budgets that involve stakeholders like farmers without specifying individual figures. Trust and the continuity of activities were highlighted as crucial factors, with a strong emphasis on the importance of building trust with stakeholders to ensure

[19] https://www.lighthousefarmnetwork.com/lighthouse-farms/lands-at-dowth

the sustainability of projects. **Financial support for third parties** was acknowledged as a simplifying factor for involving diverse partners in the Living Labs initiatives.

In the subsequent question-and-answer session, which focused on projects actively implementing Living Lab concepts, inquiries were directed towards specific projects such as Soil O-LIVE. The project's strategy to break away from **prevailing mentalities, invest in comprehensive education programmes and actively foster cooperation** was articulated. Discussions delved into farmers' perceptions of adopting new practices and their understanding of asset value beyond mere data. The nascent stage of the **voluntary carbon market** was emphasised, shedding light on farmers' concerns about emissions and the significance of carbon in the soil. The approaches employed by researchers and policymakers when engaging with farmers and establishing networks were explored, with a strong emphasis on building trust and demonstrating tangible benefits. Additionally, the methodologies in **soil-sealing processes** within cities and citizen/stakeholder involvement were elucidated, underscoring the importance of dynamic discussions and collaborative data sharing as driving forces behind progress in these initiatives.

22.2 Conclusions and the role of the Mission Soil

In conclusion, the session highlighted the crucial role of co-creation and collaboration in enhancing soil health and sustainable agriculture. Living Labs emerged as a key instrument, demonstrating a ground-up approach that brings together farmers, researchers, policymakers and citizens. These platforms are pivotal for innovating and implementing practical solutions in real-life settings.

Discussions emphasised the need to integrate human values in land use, suggesting a shift towards a more inclusive and participatory economic model that underscores networking and sharing practices. Various projects demonstrated the impact and versatility of the Living Lab concept, from addressing soil biodiversity in olive groves to urban soil de-sealing and promoting farmer-driven research.

The session closed with a call for broader engagement in soil health initiatives, emphasising the importance of collective expertise and experiences. This collaborative effort, underpinned by initiatives such as Mission Soil, plays a pivotal role in fostering a sustainable and resilient approach to soil management, offering significant benefits to communities in Europe and globally.

In response to the question, ‘What actions can or should the Mission undertake to make progress in this specific area?’ participants offered a set of key suggestions, reflecting a collective vision for advancing the Mission's objectives.

Participants highlighted the pivotal role of farmer-led initiatives in fostering sustainable agriculture and enhancing soil health. This emphasis on empowering farmers at the grassroots level was deemed foundational to the Mission's success. Furthermore, participants advocated for an increased sharing of best practices, with a focus on disseminating successful case studies and insights from Living Labs and analogous projects. The intention was to cultivate a repository of knowledge derived from proven successes, serving as a wellspring of inspiration and guidance for emerging initiatives.

A core theme was the proposal to facilitate networking and the exchange of experiences among diverse stakeholders. Participants envisaged such platforms breaking down silos, fostering collaborative learning and magnifying the impact of collective efforts. In tandem, there was a resounding call for providing comprehensive

support to potential project leaders, who grapple with the complexities of project management and funding. This encompassed offering guidance to navigate these challenges, ensuring a supportive environment for those steering transformative initiatives. Recognising the economic challenges confronted by farmers, participants championed the provision of complete financial support for active participants in these initiatives. This financial backing addressed the pragmatic realities farmers face, acknowledging their pivotal role in implementing sustainable agricultural practices. Collectively, participants advocated for a holistic approach, encompassing innovation, diversity, inclusivity and long-term sustainability to fortify the Mission's impact on the agricultural landscape.

23. Breakout session 7 - Soil biodiversity

Organised by DG AGRI's Research & Innovation Unit (F.2)

This session was organised by Vincent Tchedry and Matthias Leonhard Maier from DG AGRI's Research & Innovation Unit (F.2) and moderated by Professor Dr Wim van der Putten of Wageningen University.

The session aimed to identify various interconnected issues stemming from the decline in soil biodiversity. It aimed to underscore the importance of soil biodiversity for global food security, the SDGs, and human health by enhancing water purification, climate stability, and plant resilience against pests and diseases. Additionally, the session sought to grasp the evaluation of ecosystem services and the collection of biodiversity samples, distinguishing between abundance and variety. This understanding was considered crucial for comparing and implementing environmentally sustainable farming practices.

Figure 33. Speakers and moderators of the 'Soil biodiversity' breakout session

23.1 Keynote speeches and presentations from speakers

Professor Dr Wim van der Putten from Wageningen University & Research (WUR), introduced the session by discussing the current state of soil biodiversity. He emphasised the **increasing global attention towards soil biodiversity**, highlighting various related outreach activities and significant developments in this field. He pointed out that soil biodiversity has recently gained significant prominence on the global political agenda. This is evident

from major decisions and initiatives, such as the Soil Biodiversity Monitoring and Protection Decision[20] adopted at COP-15 of the Convention of Biological Diversity in Montreal, Quebec, in December 2022, and the 2020–2030 action plan for the international initiative for the conservation and sustainable use of soil biodiversity. Furthermore, on 5 July 2023, the European Commission proposed a new Soil Monitoring Law[21] aimed at protecting and restoring soils and ensuring their sustainable use.

Professor van der Putten introduced the Global Soil Biodiversity Initiative[22] (GSBI) and its contributions. Members of the GSBI have been instrumental in developing two European atlases on soil biodiversity, one at the European scale and another at the global scale, marking the first comprehensive assessment of soil biodiversity.

Numerous additional initiatives are underway to explore and measure soil biodiversity, such as JRC-LUCAS,[23] the Soil Biodiversity Observation Network[24] (SoilBON), the International Network on Soil Biodiversity[25] (NETSOB) and various endeavours at the national scale.

He emphasised the importance of ensuring that these activities not only enhance scientific understanding, but also inform policymaking and research programming. Despite these efforts, Professor van der Putten noted that there are still questions and challenges regarding soil biodiversity. These include finding effective indicators and sampling designs, avoiding overlaps between initiatives and translating the outputs of these initiatives into practical guidance for landowners and managers.

Dr Alberto Orgiazzi from the European Commission's JRC presented the results of the first European assessment of soil biodiversity. He began by referencing a 2016 study that produced maps indicating potential risks to soil animals and functions across Europe. The findings were concerning, showing **high potential risks for soil organisms in many areas**.

Alongside this, the JRC launched the LUCAS Soil Survey, the most extensive soil survey ever conducted. In the 2018 LUCAS Survey, additional parameters like bulk density, pesticide residues and biodiversity-related elements such as DNA for microbes and animals were introduced. However, these new criteria were applied to only a fraction of the total samples (900 samples) due to logistical challenges. For instance, fresh samples were needed for DNA analysis, requiring testing kits to be sent across Europe for on-site analysis.

In line with the EU Soil Strategy for 2023, which aimed to release the first assessment of EU soil biodiversity, two reports emerged from the LUCAS survey, each focusing on biodiversity – one for microbes and one for animals. The report on microbial communities revealed that more intensively managed agricultural areas, especially croplands, showed a greater diversity of microorganisms, particularly bacteria. However, Dr Orgiazzi stressed the importance of **considering functional aspects alongside taxonomy**. In croplands, although there is greater taxonomic diversity, there is also a higher potential for pathogens, suggesting an alternative interpretation of this finding. Similarly, the report on animal DNA echoed these findings, indicating higher diversity in highly managed areas like croplands. This could be attributed to a food web effect, where an increase in microorganisms leads to a

[20] https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-28-en.pdf
[21] https://environment.ec.europa.eu/topics/soil-and-land/soil-health_en
[22] https://www.globalsoilbiodiversity.org/
[23] https://esdac.jrc.ec.europa.eu/projects/lucas
[24] https://www.globalsoilbiodiversity.org/soilbon
[25] https://www.fao.org/global-soil-partnership/netsob/fr/

larger animal population. Additionally, **a significant overlap of taxa among different land use types** was observed, likely due to ongoing land use changes in Europe.

Dr Orgiazzi discussed the practical application of these findings, such as adopting a cluster area or 'districts' approach when discussing about soil biodiversity. Ongoing analyses under LUCAS cover several factors, including antimicrobial resistance, nutrient cycling genes, the relationship between soil biodiversity and pesticides, soil viruses, and the use of genes as bioindicators. Interestingly, the interplay between pesticide use and soil biodiversity could provide valuable insights.

A second sampling campaign was launched in 2022, doubling the data points from the previous survey. The goal of this survey was to develop a monitoring scheme through LUCAS to assess trends in soil biodiversity, considering that LUCAS data is open access and freely available for download from the European Data Centre.

Dr Orgiazzi concluded his presentation with three main messages. Firstly, **both taxonomic and functional diversity should be considered when analysing soil biodiversity**, as higher microbial and animal diversity in croplands may correlate with a larger presence of potential pathogens. Secondly, soil biodiversity conservation might be achievable through a cluster approach based on drivers, applicable to both taxonomical and functional groups. Lastly, he pointed out **knowledge gaps**, questioning the type of biodiversity we aim to protect and **the distinction between 'good' and 'bad' biodiversity.** He noted that there is still a lack of information on relic DNA and functional aspects, areas where further research could significantly contribute.

Dr Jacob Parnell from the FAO delivered a keynote speech on the importance of **soil biodiversity as the foundation for the 'One Health' principle**. He emphasised that many of the ecosystem services provided by soil are regulated by its biodiversity, making it a **crucial solution to current global problems** like pollution, food insecurity and antimicrobial resistance.

Dr Parnell highlighted the **integration of soil health as a fundamental component of the broader One Health framework**. He asserted that soil health is not just a separate component but rather the foundational element for other dimensions of health, including animal, environmental and human health. Recent studies, he noted, have revealed that **60 % of Earth's species are located in the soil**, underscoring the rich life beneath our feet.

Dr Parnell advocated for mainstreaming soil biodiversity, moving it from classroom and laboratory studies to practical solutions for real-world issues. He stressed that soil biodiversity should not be seen as a separate discipline from sustainable soil sciences (SS) and should be included in all assessments and surveys.

Regarding the conservation and sustainable use of soil biodiversity, Parnell shared that the FAO is facilitating the implementation of an action plan on soil biodiversity. This involves collecting ideas from actors active in the field and working towards a consensus on conservation priorities in different territories. He also mentioned other FAO-related initiatives in this area: the Global Soil Biodiversity Observatory (GSBO); and the International Network on Soil Biodiversity (NETSOB), established in December 2021, aiming to promote the sustainable use and conservation of soil biodiversity.

To conclude his presentation, Dr Parnell called for action to become a member of NETSOB and concluded with three take-home messages. Firstly, **soils are the foundation of most life on Earth**, deeply linked to and dependent on soil ecosystem services. Secondly, **soil biodiversity needs to be a central and mainstreamed concept globally**. Lastly, **soil biodiversity should be a global priority**, building on initiatives like NETSOB and GSBO.

Professor Dr Maria J. I. Briones from the University of Vigo introduced the Mission-funded SOB4ES[26] project and its overarching vision to make soil biodiversity and its contribution to ecosystem services visible to society while integrating it into EU policies.

SOB4ES is structured around several key objectives. The first objective is to **assess the community composition of soil biodiversity**, its spatial and temporal dynamics, its linkages with above-ground biodiversity, and ecological network structures in response to different land use types and intensities. The second objective involves understanding the **interrelationships between soil biodiversity and the provision of ecosystem services**. The third objective is to improve current evaluations of ecosystem conditions by incorporating soil biodiversity indicators into large-scale monitoring surveys and land management planning. Lastly, the project aims to **integrate ecological knowledge of soil biodiversity into the daily life of a broad range of Europeans**, including stakeholders, policymakers and citizens.

To put these goals into action, the project is divided into several work packages (WPs). Professor Briones gave an overview of selected WPs and the challenges they face. WP 2 focuses on **analysing soil biodiversity under different land use intensities**, looking at genetic diversity, species diversity and ecosystem diversity at various scales. Challenges in this WP include dealing with different soil metrics and methodological constraints, like difficulties in comparing data from genomics and morphology assessments. Building on WP 2, WP 3 aims to understand how soil biodiversity and ecosystem services are connected across different land use intensities and pedo-climatic regions. This will help to grasp **how factors affecting soil biodiversity also affect soil function and ecosystem services**. Lastly, WP 5 explores ways to make soil biodiversity and its contribution to ecosystem services more visible to society and integrate them into EU policies. This involves engaging stakeholders and promoting knowledge exchange to ensure soil biodiversity's importance is recognised and acted upon in policy and society.

Gérard Rass from APAD discussed the **shift from traditional soil degradation to soil conservation** by understanding soil biodiversity, particularly in the context of annual crops. He began by introducing APAD, its members and associated organisations.

Gérard Rass highlighted the impact of traditional farming practices on soil health, focusing on biodiversity. He pointed out the **damages caused by excessive ploughing and tillage practices**, such as the use of a rotative hoe, which ultimately lead to erosion and runoff phenomena. Additionally, he mentioned the pollution resulting from the **excessive use of fertilisers** (nitrates and phosphorous) **and pesticides** in traditional cropping systems.

Contrasting these conventional farming systems, Rass advocated for improving the sustainability of farming ecosystems by mimicking the functioning of natural ecosystems, which heavily rely on biodiversity. He emphasised that **this paradigm shift towards sustainable practices need not compromise yield satisfactorily**.

He then presented the **three pillars** of conservation agriculture, which should be implemented simultaneously in an iterative system: **no tillage** and direct seeding to **limit soil disturbance**; **permanent soil cover** through cover crops and the use of crop residues left on the soil, **maximising photosynthesis** and **aiding carbon sequestration**; and **on-farm diversity**, such as rotation and diversification of crops, to introduce diversity in time and space.

[26] https://cordis.europa.eu/project/id/101112831

Rass discussed the difficulties faced by farmers in implementing conservation farming. These include the perception of lower yields, which he argued is not necessarily true as conservation agriculture can sometimes ensure higher yields compared to conventional systems. Other challenges include the need for know-how from technical/scientific advisers and peer-to-peer learning, the necessity for farmers to see conservation practices in action, the need for legislative and bureaucratic freedom, and adequate recognition from society. He argued that the CAP should more explicitly encourage soil conservation.

To evaluate progress in soil conservation, Rass advocated for more indicators at the farm level that are results-driven, easy to understand and reflective of the sustainability of agroecosystems. This approach, he suggested, would effectively demonstrate the benefits of conservation agriculture, promoting its wider adoption among farmers.

The **question-and-answer session** tackled an apparent inconsistency between two presentations related to soil biodiversity. While the LUCAS survey suggested notable biodiversity in cropped land, Rass's presentation argued that conventional farming negatively impacts soil biodiversity. It was clarified that the LUCAS survey lacks the ability to distinguish between different management regimes, making it challenging to isolate data from conventional versus conservative management. This clarification underscored the complexity of interpreting survey results.

The discussion then shifted towards regulatory matters, focusing on Annex 1 of the proposed Soil Monitoring and Resilience Directive and indicators for soil biodiversity. A notable point of debate was the efficacy of using ‘abundance’ alone as an indicator, with a suggestion to incorporate a more functional aspect. The role of arbuscular mycorrhizae fungi as an indicator of soil quality was introduced, highlighting the nuanced considerations in selecting indicators that truly reflect the health and functionality of the soil.

The tension between biodiversity conservation and ecosystem functionality emerged during the discourse. The need for a holistic approach that evaluates ecosystem biodiversity as a whole was emphasised, challenging the prevailing species-centric focus embedded in certain EU Directives addressing nature conservation.

Economic viability discussions explored the impact of practices that safeguard soil biodiversity on land prices and the willingness of stakeholders to invest. The suggestion to integrate biodiversity considerations directly into discussions about land values faced challenges, primarily due to the lack of awareness among land users and managers regarding the ecosystem services provided by biodiversity. A proposed solution was to highlight the connection between land value and specific soil characteristics, such as structure and water retention, which are known to be influenced by soil organisms. Participants also delved into the **impact on yield**, a **critical factor** influencing farmers' decisions to adopt conservation practices. It was emphasised that the broader concept of soil quality, often oriented towards maximising yield, does not necessarily align with the notion of soil health, which involves a trade-off between yields and the provision of ecosystem services. This nuanced understanding shed light on the complex relationship between soil biodiversity and agricultural productivity, introducing the idea that high levels of biodiversity might not necessarily correlate with higher yields. Instead, when considering yield stability, soil biodiversity can play a crucial role in mitigating vulnerability and fluctuations in yield, especially those linked to the impacts of climate change.

Following the panel discussion, the audience was invited to reflect on the primary needs and challenges for efficiently promoting the implementation of sustainable farming practices beneficial to soil biodiversity. With respect to R&I, participants highlighted the following gaps:

- lack of knowledge concerning the functionality of soil biodiversity within agricultural ecosystems;

- absence of clear indicators and thresholds for soil biodiversity, including its role in soil health and productivity;
- difficulties in translating the scientific understanding of soil biodiversity into practical guidelines for farmers and stakeholders.

Broadly speaking, key obstacles mentioned during the discussion and hindering the widespread adoption of biodiversity-enhancing practices in farming include:

- implementation hurdles, such as those linked to biodiversity assessments and inadequate supply chains for regenerative products;
- economic aspects, i.e. perceived high costs associated with such practices;
- lack of accessible tools and resources for farmers to implement sustainable practices.

In proposing ways for Mission Soil to effectively address these challenges, participants articulated a few key suggestions, including:

- advocating for regenerative farming practices through legislative changes;
- establishing an international open-access database to share project outcomes and best practices;
- enhancing literacy and awareness about soil biodiversity among stakeholders;
- guiding policy measures that incentivise sustainable farming;
- ensuring substantial investments in research for soil biodiversity mapping;
- active involvement of farmers in steering committees;
- alignment of Mission Soil outcomes with future CAP revisions;
- implementation of demonstration projects;
- securing sustained funding for long-term initiatives like Living Labs and experimental fields.

Overall, the comprehensive discussion and reflections highlighted the intricate challenges and potential solutions in promoting sustainable farming practices that contribute to soil biodiversity. The nuanced perspectives from the panel and audience emphasised the need for a holistic and collaborative approach, integrating scientific knowledge, economic considerations and farmer engagement to achieve meaningful progress in the Mission towards preserving and enhancing soil biodiversity.

23.2 Conclusions and the role of the Mission Soil

The session highlighted the increasing global attention toward soil biodiversity, driven by significant decisions and initiatives at the EU and global level. Initiatives such as GSBI,[27] LUCAS,[28] SoilBON,[29] and others have contributed to understanding soil biodiversity, but challenges persist. These challenges include avoiding overlaps between initiatives and translating outputs for practical land management.

[27] https://www.globalsoilbiodiversity.org/objectives
[28] https://esdac.jrc.ec.europa.eu/projects/lucas
[29] https://www.globalsoilbiodiversity.org/soilbon

Specifically, audience discussions underscored knowledge gaps, i.e. the lack of adequate soil biodiversity indicators and the difficulties in translating the scientific understanding of soil biodiversity into practical guidelines for farmers. The perceived high costs linked to the implementation of soil-biodiversity-friendly practices remains a significant hurdle in adopting biodiversity-enhancing farming practices.

Proposed solutions for the Mission Soil encompass advocating for legislative changes, investing in research as well as literacy across a wide range of stakeholders, aligning outcomes with future policy revisions, i.e. the CAP, and finally secure sustained funding for long-term initiatives, such as Living Labs and experimental fields.

24. Breakout session 8 – Business models for soil health

Organised by DG AGRI's Research & Innovation Unit (F.2)

The session was organised by Luis Sánchez and Fiorella Puopolo from DG AGRI's R&I Unit (F.2) and moderated by Johan De Fraye, Mission Soil Board Member. The session focused on the business case for investing in soil health. The session aimed to shed light on the multi-faceted business cases for investing in soil health across different land uses while acknowledging the challenges and barriers associated with this long-term endeavour. Success stories and investment experiences related to soil health in Europe were presented, offering insights into effective strategies. Additionally, the meeting addressed how Mission Soil is taking steps to tackle the challenges and promote sustainable soil management and restoration.

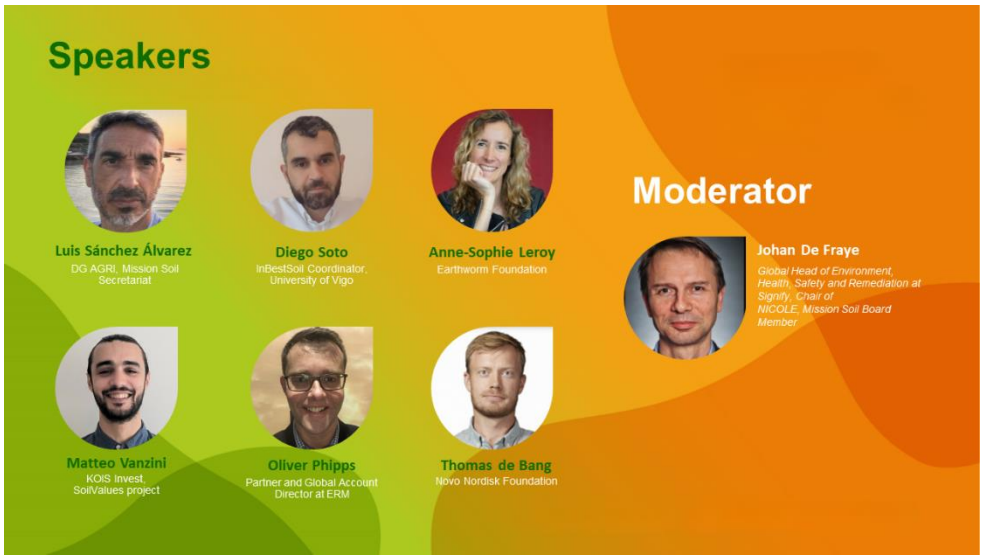

Figure 34. Speakers and moderators of the 'Business models for soil health' breakout session

24.1 Keynote speeches and presentations from speakers

Luis Sánchez Álvarez's presentation delved into the business dimension of the Mission Soil, emphasising the need for **new (policy) incentives and business models to encourage practices beneficial to soil health** throughout value chains. The three key dimensions outlined involve analysing the relationship between current business models and soil degradation, assessing existing models and incentives related to soil health and ecosystem services, and co-developing and implementing business cases. The 2023 Mission's revision emphasises

the essential role of **significant investments from the private sector and philanthropy** to achieve the deployment and replication of solutions at scale.

The presentation highlighted three Mission projects (InBestSoil,[30] NOVASOIL,[31] and SoilValues[32]) focused on incentives and business models for soil health. The expected outcomes of these initiatives include increased awareness of the value of investing in soil health, enhanced investment opportunities across value chains, diversified income for land managers and the creation of new value chains and products for informed consumer decisions. The European Investment Bank's study on investment needs assessment within the Mission Soil (expected to be finalised in Q1 2024) will identify market players, potential investment opportunities, barriers and opportunities for investment, quantifying investment needs, and recommending financial and non-financial instruments to address these needs.

In his presentation on the InBestSoil approach, **Diego Soto**, the Project Coordinator, outlined the conceptual framework within the context of the Mission call, focusing on **incentives and business models for soil health**. The project, funded under this call, aims to develop sustainable business models that prioritise soil health, encouraging investment in practices that benefit both the economy and the environment.

InBestSoil's strategy involves **valuing ecosystem services in financial terms** to integrate soil health into core business strategies. The project plans to analyse soil health, conduct economic valuations, assess existing business models and explore possibilities for upscaling. The use of the **Triple Layered Business Model Canvas**, breaking down business logic into environmental, social and economic components, is highlighted as a crucial tool for designing self-sustainable models. The presentation concluded with a call for collaboration, emphasising the significance of promoting awareness, creating solid business models and integrating economic valorisation of soil ecosystem services to address the challenges of soil health collectively. The online collaborative platform established by InBestSoil serves as a valuable resource for collaboration and knowledge sharing among stakeholders in the soil health domain.

In her presentation, **Anne-Sophie Leroy** discussed the business case for **soil health within the food value chain**, presenting insights from Earthworm, a foundation operating in 16 countries that collaborates with agriculture companies committed to transforming their supply chains for environmental and social impact mitigation. Leroy emphasised that **supply chain actors**, including companies, cooperatives and farmers, have a tangible business case for investing in soil health. Companies seek to meet public commitments related to carbon reduction and address concerns about soil fertility affecting plant nourishment, potentially impacting yields. Farmers, on the other hand, see a business case in achieving farm autonomy and exploring new markets under regenerative agriculture practices.

Leroy outlined the **challenge of aligning diverse business models** and goals across the supply chain and emphasised the **need to build consensus** among actors. Earthworm's approach involves developing a technical framework with impact indicators and performance indicators for agricultural practices. Leroy described a three-level framework, including broad impact indicators for companies, performance indicators for assessing farmers' practices, and Technical Support indicators for coaching farmers. She provided examples of implementing these

[30] https://inbestsoil.eu/
[31] https://novasoil-project.eu/
[32] https://soilvalues.eu/

frameworks in the field, such as collaboration with supply chain actors in the north of France, particularly with Vivescia, a large cooperative. The initiative involves setting targets, upskilling technicians, implementing monitoring systems and securing financial support, demonstrating a holistic and collaborative model involving various downstream, midstream and upstream actors.

In his presentation on 'The catalytic effect of innovative finance in supporting farmers' transition,' **Matteo Vanzini** from KOIS Invest explored how **innovative finance can aid farmers in transitioning to soil health** and regenerative practices. KOIS Invest is an impact finance organisation focused on designing structured investments and fund management with a track record of bringing innovative finance products to market, particularly in the areas of education and employment, healthcare and climate and nature, where agriculture is a key lens.

Vanzini outlined the psychological, technical, financial and market-related barriers that farmers face in transitioning to soil health practices. Despite the recognised benefits of soil health, challenges such as perceived risk, innovation aversion, additional costs and market immaturity hinder widespread adoption. To address these challenges, Vanzini introduced the concept of **blended finance**, emphasising the **need to innovate financial instruments to support farmers effectively**. Blended finance involves bringing together different types of capital and risk appetites, including philanthropic, public and commercial capital. Vanzini proposes leveraging blended finance to **create a mix of instruments** that can address the evolving needs of farmers throughout the transition process. This approach allows for the mobilisation of diverse capital sources, filling technical assistance gaps, offering attractive propositions to investors and mitigating risks through instruments like insurance. Blended finance is positioned as a powerful tool to bridge the gap between the time horizon of farmers' transition to soil health and regenerative agriculture and that of investors, ultimately supporting a sustainable and prolonged transition.

In **Oliver Phipps**' presentation from NICOLE[33] (Network for Industry Co-ordinated Sustainable Land Management in Europe), he emphasised the parallels between the management of contaminated land and brownfield development and the potential for the industry to contribute significantly to the EU's soil objectives. The focus is on reducing soil pollution, and Phipps drew on the **industry's experience over the past 50 years in managing contaminated land** to share insights into its evolution. He highlighted the policy environment's transformation, moving from cleaning to background, risk-based management and the integration of sustainability. Phipps underscored the importance of addressing emerging areas such as climate resilience and nature-based solutions in the context of brownfield development. The presentation emphasised the **industry's shift towards** not only risk and liability management, but also **value creation and generation**, aligning with the broader goals of sustainable land management.

Phipps provided critical indicators for building business cases at a site and portfolio scale, including financial or economic, environmental, and social aspects, all of which can be quantified and monetised. The presentation offered examples from the mining sector and an oil and gas company, demonstrating how these industries are considering economic, environmental and social benefits in decision-making processes. Phipps concluded by highlighting **three high-level areas crucial for building business cases**: quantifying and monetising indicators; focusing on materiality; and using investor language and frameworks to effectively communicate the benefits of sustainable land management.

[33] https://nicole.org/

In **Thomas Bang**'s presentation on behalf of the Novo Nordisk Foundation, he outlined the foundation's corporate and philanthropic purposes, emphasising its focus on improving people's health and the sustainability of society and the planet. With three overarching themes – health, sustainability and the life science ecosystem – the foundation places a significant emphasis on sustainability, particularly within the food system. Four key sustainability themes include agriculture, food, high-impact climate change mitigation technologies, and supporting society in the green transition, with a primary focus on the food system.

Bang highlighted the critical **role of soil health in addressing major societal challenges** such as biodiversity loss, climate change, food security and rural development. He discusses potential tools, mechanisms and business models to drive positive change in soil health, emphasising the influence of EU-level regulations, the CAP, national regulations and the importance of addressing scope three emissions. Notably, he pointed to the **pharmaceutical industry**, as an example of a **sector willing to pay premium prices to farmers for sustainable practices**, emphasising the potential for collaboration between various industries to drive positive change in soil health. Bang also underscores the **role of philanthropy**, including supporting research, innovation, education, outreach and advocacy, with foundations being uniquely positioned to take higher risks than governments and industries in advancing sustainable practices.

The **panel discussion** delved into critical aspects of soil health and business models, revealing insights from various perspectives. Oliver Phipps emphasised the significance and need for long-term planning in sustainable land management. He highlighted the evolving nature of contaminated land management, transitioning from waste-focused approaches to sustainable remediation and land stewardship.

Matteo Vanzini stressed the role of impactful initiatives in regenerative farming, emphasising the need for financially minded philanthropic organisations and blended finance. The discussion extended to applying successful practices from brownfield redevelopment to improving forestry and agricultural practices. Phipps outlined three key areas applicable to agriculture: identifying the right indicators; measuring and monetising them; and scaling practices effectively.

The conversation shifted towards the benefits of impact investing in regenerative agriculture. Vanzini emphasised the wide-ranging impact on climate, nature and sustainability while acknowledging the evolving nature of the business case based on the timeline of intervention.

The panel addressed challenges related to the tragedy of the commons, emphasising the **necessity of systemic shifts**. Anne-Sophie Leroy discussed the transformative effect of the cooperative-centred model, illustrating a snowball effect triggering scalable projects. The conversation explored how to communicate the value proposition, adapt frameworks for agriculture and make sustainability appealing to consumers.

The discussion also touched on the **willingness of industrial businesses to include soil health in their models**. Leroy pointed out downstream players' incentives and the role of consensus-building. The challenges of growing inequality and the potential increase in food prices due to soil health initiatives were discussed, highlighting the need for additional income sources and education.

The panellists shared their criteria for success in funded projects, focusing on real impact and tangible outcomes. Thomas de Bang highlighted the shift from traditional metrics to emphasising tangible impacts on people and nature.

In the interactive segment, the audience raised concerns about suspicion regarding greenwashing in capitalism. The panellists responded by emphasising the importance of tangible impact and the involvement of all stakeholders in achieving progress. The audience also participated in a poll, addressing challenges in soil health business models and suggesting actions for Mission Soil, such as enhancing collaboration, sponsoring pilots and spreading knowledge.

24.2 Conclusions and the role of the Mission Soil

The presentations highlighted various dimensions of the Mission Soil initiative, emphasising the need for new incentives and business models to promote soil health. Key aspects included analysing the relationship between current business models and soil degradation, proposing primary funding from Horizon Europe and public sources, and showcasing projects focused on incentives for soil health.

The importance of collaboration and sustainable business models, valuing ecosystem services in financial terms, and integrating soil health into core business strategies were key themes. The business case for investing in soil health within the food value chain, challenges in aligning diverse business models and the role of consensus-building were discussed. Innovative finance, particularly blended finance, was explored to support farmers' transition to soil health, addressing barriers such as perceived risk and market immaturity. Philanthropy can be a good avenue for testing and experimenting with potential innovative solutions.

The significance of soil health in addressing societal challenges, potential business models and the role of philanthropy in supporting sustainable practices were also underscored. Insights from the management of contaminated land and brownfield development highlighted the industry's shift towards value creation and sustainability. Investors need a clear and simple set of indicators to assess the benefits and return on investment.

The panel discussion further delved into critical aspects, including long-term planning in sustainable land management, the role of impactful initiatives in regenerative farming, challenges related to the tragedy of the commons and criteria for success in funded projects, emphasising tangible impact and stakeholder involvement.

Mission Soil holds the potential to drive transformative change by advocating for soil-friendly policies, securing diverse funding sources, overseeing impactful projects like InBestSoil and NOVASOIL, conducting research, fostering awareness and encouraging collaboration among stakeholders. By actively engaging in philanthropic support, offering guidance on funding opportunities, and facilitating interactive discussions, Mission Soil can play a crucial role in advancing sustainable business models, addressing soil health challenges, and contributing to broader societal and environmental goals.

Annex

Annex: Statistics from the event

1. Attendees by country of origin

In total up to **281**[34] in-person participants were registered at the entrance throughout the three-day event. Of them, **60 %** identified as female, **38 %** as male, and **2 %** chose not to disclose their gender. A total of **41 %** of these attendees came from Spain followed by Belgium with **8 %** and Italy with **7 %** participants. Other countries had varying representation, with most having fewer than **5 %** attendees.

A significant majority, **95 %,** of attendees came from the EU, namely **23 out of the 26** countries attending the event were European. The notable presence of Spanish attendees emphasises the influence of the event's location, while Belgium's second-highest representation is attributed to influential stakeholders from the country.

2. Attendees by organisation type

The event garnered attendance from a diverse spectrum of stakeholders, with the 'Research community' emerging as the most populous category, comprising **28 %** of participants. Following closely were 'Public research funders (public agencies and institutions)' with **18 %**, and 'Education (higher education)' with **14 %**. Notably, categories such as 'Private sector, businesses, industries, supply, and retail actors' and 'Policymakers and governance' each accounted for **10 %** of the attendees. Other represented stakeholder groups encompassed 'Service providers,' 'NGOs, civil society organisations, associations,' 'Farmers, foresters, spatial planners,' 'Soil advisors,' 'Journalists, media,' 'Private research funders and investors,' 'Soil users/managers/owners' and 'Artists, cultural and creative industries'.

3. Attendees' affiliation with projects

The bar graph below shows how many attendees were connected to a project. Out of the total number of participants (N.) 165 (**59 %**) were part of a project, while 116 (**41 %**) were not linked to any project.

The graph suggests that a majority of the attendees were linked to Mission Soil projects, showing a strong connection to the initiatives featured.

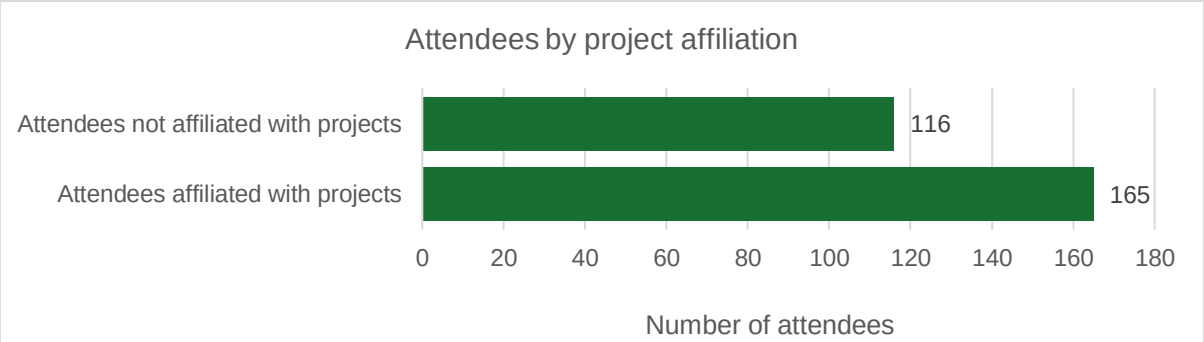

Figure 35. Attendees by project affiliation

[34] The number does not include 92 speakers and moderators, which attended the event over the three days.