



AGROECOLOGY PARTNERSHIP



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2nd annual report on state of play

Conveners: Emmanuelle Cariou (ANR) and Stéphane Bellon (INRAE)



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EXECUTIVE SUMMARY

The second European Panel for Agroecology Transitions (EPAT) took place the 1st of October 2025 in the Town Hall at Malmö, Sweden. The 2nd EPAT was held back to back to the Agroecology Europe Forum 2025. The EPAT was coordinated by Stéphane Bellon (ANR) and Emmanuelle Cariou (ANR) and co-organized with Hubert De Jonge (Aarhus University, DK), Johannes Bender (BLE, DE), Ivana Trkulja (ICROFS, Aarhus University); Théo Paquet (EEB), Marta Rivera Ferre, (CSIC-UPV), Daniel López-García (CSIC-UPV) and Allison Loconto (INRAE). All are contributing to the Task 2.3 from the WP2 on science policy of the AGROECOLOGY Partnership.

The Panel itself contains 27 members including researchers, policy officers and relevant stakeholders contributing to agroecology in Europe such as farmers and their organisations.

The choices made in the agenda in terms of approach (mix of communications, round table and workshops) helped to enhance interactions between actors who had, for most of them, no professional interactions before this event. Participation to the EPAT was split into core group (permanent members of the Panel) and guests having expertise on the specific topic addressed (10 speakers).

The topic of the day focused on the “soil nexus” within agroecological transitions, highlighting the central role of soils in achieving sustainable food systems and climate resilience. The introductory session, led by Stéphane Bellon and Hubert de Jonge, traced the historical evolution of agroecology, showing how soils have progressively become a core component of agroecosystem thinking and policy frameworks, including those of the Food and Agriculture Organization (FAO) and the HLPE. At the same time, soils are increasingly threatened by degradation processes such as erosion, compaction, and contamination, with global assessments indicating that up to 90% of soils could be at risk by 2050.

The presentations emphasized the complexity of defining and assessing soil health, which relies on integrated physical, chemical, and biological indicators. Current efforts at the European level, including the forthcoming Soil Monitoring and Resilience Directive presented by Mirco Barbero, aim to harmonize monitoring systems, improve data availability, and support soil restoration. These initiatives are embedded within broader EU strategies such as the European Green Deal and Mission Soil, which seek to achieve healthy soils across Europe by 2050.

A key theme of the discussions was the gap between scientific knowledge and policy implementation. Insights, presented by Ivana Trkulja, revealed that while agroecological practices are partially recognized in policies, they are not yet sufficiently supported to enable systemic transitions. Differences in the understanding of agroecology across countries, along with misalignments in advisory systems and funding mechanisms, remain major barriers.

The concept of the soil nexus was further explored by Patrick Lavelle, who highlighted the importance of integrating environmental and social externalities into agricultural policies.

Round table discussions reinforced the need for a holistic and multi-actor approach to agroecological transitions. Contributions from policymakers, researchers, farmers, and civil society emphasized the importance of local governance, access to land, farmer training, and policy coherence. Soil was not only framed as a biophysical resource but also as a social and political issue, closely linked to land tenure, generational renewal, and the risks of commodification through carbon markets.

Breakout sessions provided practical insights into implementation challenges and opportunities. Discussions on the Soil Monitoring Law highlighted the importance of region-specific indicators, the role of farm advisors in translating data into practice, and the need for clear thresholds and actionable recommendations. Case studies such as the Northern Ireland Soil Nutrient Health Scheme illustrated how large-scale monitoring programmes can support both policy objectives and farmer decision-making through data integration, training, and incentives.

Finally, the workshop addressed soil carbon sequestration as a key lever for climate mitigation in a session led by Cornelia Rumpel. Soils were identified as the largest terrestrial carbon reservoir, with significant potential to act as carbon sinks. However, carbon sequestration involves important trade-offs and depends on complex interactions between biological, chemical, and physical processes. Agroecological practices—such as crop diversification, cover cropping, and agroforestry—were highlighted as effective strategies to enhance soil organic matter while improving biodiversity and resilience.

In conclusion, the workshop underscored that achieving sustainable soil health requires a holistic, systemic, and context-specific approach. Strengthening the science–policy interface, improving soil monitoring systems, supporting farmers through advisory and training structures, and fostering collaboration among stakeholders are essential steps.



INDEX

1. Introduction to the 2nd EPAT.....	5
2. Soil nexus and its complexity by Patrick Lavelle, (Sorbonne University)	7
3. Round Table: Framing and implementation of agroecological transitions, focusing on soil nexus. Round Table. Participants: Eduard Hernández Nualart (EC Via Campesina), Gunilla Andersson (Malmö local government), Francesca Ricardi (ERRIN), Jan Moudrý (University of Tomas Bata in Zlin), David Amudavi (Biovision Africa Trust), Emmanuel Petel, (DGAgri). Moderator: Marta Guadalupe Rivera Ferre (CSIC).	8
4. Upcoming European Directive on Soil monitoring and Resilience by Mirco Barbero (DG Env)	10
5. Breakout session: Impacts of the future European soil law at the local level, including users’ impacts”, by Rainer Baritz (European Environment Agency), moderators: Hubert de Jonge and Theo Paquet	11
6. Breakout session: “Show cases at the regional level” speaker Dr Rachel Cassidy, Agri-Food and Biosciences Institute (AFBI), moderators Emmanuelle Cariou, ANR and Gabriele Ridolfi, FIBL)	14
7. Breakout session: added services of the Soil Monitoring Law, mitigating climate change: how do we enhance carbon sequestration following the AE principles, (speaker Cornelia Rumpel, INRAE, moderator Jan Mouldry, Karim Jouhari, IFOAM).....	16
8. Outlook – Agroecological Transitions with a Focus on soil and land management	18



Table 1: List of Participants

Firstname	Surname	Organization/Name of company
David	Amudavi	BIOVISION Africa Trust
Mirco	Barbero	DG Env EU commission
Rainer	Baritz	European Environment Agency
Stéphane	Bellon	Agence Nationale de la Recherche
Johannes	Bender	BLE - Federal Office for Agriculture and Food in Germany
Gianluca	Brunori	University of Pise
Stefano	Bruzzese	MASAF
Emmanuelle	Cariou	Agence Nationale de la Recherche
Rachel	Cassidy	Agri-Food and Biosciences Institute (AFBI), Northern Ireland
Henriette	Christensen	Agroecology Europe
Hubert	de Jonge	Aarhus University DCA
Gonca	Evran Dogan	TAGEM
Eleonore	Faure	FORMAS
Cristina	Gallardo Rey	Oficina de Proyectos Europeos del Sistema Extremeño de Ciencia y Tecnología
Susana	Gaona Saez	DG Agri European Commission
Jorge	Gomez Romero	CAPADR
Eduard	Hernández Nualart	EC Via Campesina
Juan	Jauregui	CAPADR
Susanne	Johansson	Formas
Karim	Jouhari	IFOAM Organics Europe / TP Organics
Patrick	Lavelle	IRD
Allison	Loconto	INRAE
Daniel	López-García	Institute of Economics, Geography and Demography, Spanish National Research Council
Matteo	Metta	Agroecology Europe
Jan	Moudry	University of Tomas Bata in Zlin
Lisa	Nixdorf	BIOVISION Africa Trust
Aykut	Ordukaya	TAGEM
Theo	Paquet	EEB
Emmanuel	Petel	DG Agri European Commission
Francesca	Ricardi	Free University of Bozen / Bolzano
Gabriele	Ridolfi	FIBL
Marta Guadalupe	Rivera Ferre	CSIC
Cornelia	Rumpel	INRAE
Ivana	Trkulja	ICROFS - International Centre for Research in Organic Food Systems, Aarhus University
Karin	Ulmer	Independent consultant
Anna	Vaarst	ICROFS - International Centre for Research in Organic Food Systems, Aarhus University



1. Introduction to the 2nd EPAT

Introduction by Stéphane Bellon and Hubert de Jonge (AAU), state of play on the topic “soil nexus in the agroecology transitions”

This presentation introduced the objectives and long-term vision of the EPAT panel.

The speakers began by explaining that the connection between soils and agroecology has deep historical roots. As early as the 1930s, agroecology was described as a science dedicated to soil conservation¹, a perspective later reinforced in foundational works such as those of Altieri², and Caporali³. From the 1980s onward, agroecology progressively adopted a systemic perspective centred on agroecosystems, in which soils and the concept of soil health became essential components. This evolution was formally recognised in 2020 through their inclusion in both the HLPE’s agroecology principles and the FAO’s framework. Recent scientific literature, including the review by Galt et al.⁴, highlights the increasing centrality of soils in biophysical sciences addressing agroecology.

The speakers then turned to the multiple threats facing soils worldwide. They described soils as the Earth’s “living skin,” an essential yet fragile interface exposed to processes such as compaction, contamination, degradation, and sealing. Such threats also affect soil functions and associated ecosystem services. Global assessments by the FAO⁵ indicate that one third of the world’s land is already degraded, with the proportion reaching 40% in Africa, and that as much as 90% of Earth’s topsoil could be at risk by 2050. Research such as the work of Naveed *et al.*⁶ on soil structure and compaction further illustrates the vulnerability of soils to physical degradation. At the European level, the EU Soil Observatory (EUSO) dashboard shows the widespread extent of land likely to be affected by one or more soil degradation processes.

The concept of soil health was then examined in depth. Soil health assessments draw on multiple indicators covering physical, chemical and biological characteristics of soils, as summarised in scientific syntheses such as that by Bünemann *et al.*⁷. Evaluating soil health effectively requires harmonisation of methods, multi-criteria frameworks, and carefully designed sampling strategies involving depth, frequency and seasonality. Scale considerations—from local plot measurements to continental monitoring systems—add further complexity. Matson *et al.*⁸ propose an assessment framework for soil health based on three reference values: **targets**, the desired conditions to be achieved; **thresholds**, the critical values not to be exceeded; and **benchmarks**, used when threshold values cannot be determined.

The speakers finally reviewed the trajectory of soil-related legislation in the European Union. A Soil Framework Directive proposed in 2006 was never adopted and was ultimately withdrawn in 2014 after prolonged opposition in the Council. However, renewed momentum has emerged through the EU

¹ Bensing, B. (1938). "Agroecology as a basic science of soil conservation." *Soil Conservation* 152: 138-141

² Altieri, M.A. (2002). *Agroecology: The science of sustainable agriculture*.

³ Caporali, F. (2015). *History and Development of Agroecology and Theory of Agroecosystems*. In M. Monteduro et al. *Law and Agroecology. A transdisciplinary dialogue*. Springer Ed. Pp 3-29

⁴ Galt, R.E., et al. (2024). *Review on soil-related trends in agroecology literature*. *Agricultural Systems* 206.

⁵ FAO. (2020). *State of soil resources and global degradation report*.

⁶ Naveed, M., et al. (2014). "Soil structural stability and compaction." *Soil Sci. Soc. Am. J.*, 78, 1239–1250.

⁷ Bünemann, E.K., et al. (2018). "Soil quality: A critical review." *Soil Biology and Chemistry*, 120, 105-125.

⁸ Matson et al 2024 *Four approaches to setting soil health targets and thresholds in agricultural soils J. of Env Management*.



Soil Strategy for 2030 and the Soil Deal for Europe, both part of the European Green Deal. A new Soil Monitoring and Resilience Directive, expected in 2025, sets a non-binding ambition of achieving healthy soils across the EU by 2050⁹. The protection of soils is also indirectly supported by several existing instruments, including the Common Agricultural Policy, the Nitrates Directive, the Nature Restoration Regulation, the Land Use and Forestry Regulation (LULUCF) and regulatory frameworks for chemicals.

The speakers also described the implementation of the EU Mission Soil since 2021¹⁰. This mission is being advanced through an extensive portfolio of more than forty projects. These include innovation projects focused on the circular economy, biodiversity enhancement, pollution reduction, business models, soil-friendly practices and desertification prevention. A network of twenty-five Living Labs has been established, with twenty more under preparation¹¹. Numerous soil monitoring projects complement these efforts, along with initiatives dedicated to soil literacy, communication, and citizen engagement. The mission is further strengthened by several cross-cutting projects supporting coordination and knowledge integration.

The presentation concluded with a synthesis of the Mission Soil's main operational objectives: developing capacities and strengthening the knowledge base for soil stewardship; co-creating and scaling up place-based innovations that support soil health; tracking progress through an integrated soil monitoring system; and engaging soil users and society more broadly.

Intervention of Ivana Trkulja, AU-ICROFS, contribution to the 2nd EPAT from Work Package 2

The presentation provides an overview of Work Package 2 (WP2) of the European Partnership for Agroecology Transition (EPAT), which focuses on strengthening the science–policy interface to support agroecological transitions across Europe. WP2 consists of two main components: benchmarking existing scientific and sectoral policies relevant to agroecology, and improving the capacity and governance of science-based policy advice at both national and trans-European levels.

To better understand how agroecology-related policies are currently designed and adopted, WP2 launched a comprehensive Science–Policy Interface Study. This included a multi-stage survey targeting national and regional policymakers as well as research-performing organisations. A pilot was conducted in autumn 2024, followed by a first full phase in spring 2025, with a second phase planned for autumn 2025.

Findings from the pilot phase indicate that although some agroecological practices are acknowledged in existing policies, these policies do not yet adequately support systemic agroecological transitions. Respondents noted misalignment between the organisation of food systems, advisory structures, and funding mechanisms (such as the CAP) and the needs of an effective agroecological transition. European policies were perceived as somewhat more supportive than national or regional ones.

In the first full survey phase, responses were dominated by Spain and Italy, requiring weighted averages for cross-country analysis. Respondents highlighted that the understanding of agroecology varies significantly across countries and stakeholder groups. In some regions, agroecology is viewed primarily as a scientific or technical concept, while others emphasise its social and political dimensions. A shared

⁹ European Commission. (2006–2025). *Soil-related legislative documents and strategies (SFD, Soil Strategy for 2030, Soil Deal for Europe, SML Directive)*.

¹⁰ European Commission. (2021–2024). *Mission Soil Implementation Plan and project overview*.

¹¹ Mission Soil Platform. (2024). *Documentation on Living Labs, Lighthouses and thematic projects*.



national definition is often lacking, and better integration of agroecology into education, advisory services, and territorial development strategies is considered essential.

Survey participants also assessed the importance and implementation of various dimensions of agroecology—principles, practices, science, social movements, and economic and policy conditions. Practices such as organic farming, mixed farming, and agroforestry are not widely applied or sufficiently supported by current policies. Respondents further expressed that both European and national policies remain insufficient to foster agroecological transitions, though EU-level policies are viewed slightly more favourably.

The presentation concludes with insights from the Task Force Hermes Workshop (September 2025). Key messages emphasise that agroecology should be seen as a continuum rather than a fixed endpoint, and that agroecological indicators and practices must be context-dependent. A strong science–policy interface requires attention to policy coherence, citizen initiatives, advisory and educational systems, and farmer-to-farmer exchanges. Moreover, benchmarking agroecological transitions should adopt a food-systems perspective and focus on organisational solutions beyond the farm level.

2. Soil nexus and its complexity by Patrick Lavelle, (Sorbonne University)

Patrick Lavelle introduces Agroecological practices that combine agricultural production and optimal preservation of soil ecosystem services which are now experiencing very strong momentum worldwide. Preferred by many farmers for a variety of reasons—health, economic, and social—they are competing with entrepreneurial and industrial models. Strengthening the Common Agricultural Policy in their favor will allow many farmers, mostly smallholders, to embark on the difficult transition from one model to the other. The obstacles to overcome are numerous, primarily technical and economic in nature. It is necessary to strengthen technical support through targeted training and increased support for research. It is also important to support farmers during the economically perilous phase of transitioning from a conventional to an agroecological system. The challenge then becomes restoring the biological processes essential for its proper functioning as quickly as possible, given that conventional methods have largely damaged this potential. At all these stages, support should focus more on the environmental and social externalities of practices than on direct production support. This means measuring and integrating the impact of practices into policies. It also means treating practices with negative externalities—due to their health and environmental costs to society—differently from those that, by fully utilizing the soil's potential to store carbon, maintain biodiversity, and infiltrate, retain, and purify water, restore the soil's environmental functions. Added to this is the social challenge of attracting young professionals to agriculture with specific technical skills and a life project aligned with agroecology.

The measurement of externalities requires using an indicator that meets three criteria: be based on a clear conceptual framework, be statistically linked to environmental externalities, and be measurable by the farmer. The global macrofauna indicator (GMI)¹² meets the three conditions. It was designed to provide farmers with a simple and reliable tool for assessing the ecosystem services provided by the soils they manage. We demonstrate that soil macrofauna, which comprises a wide diversity of ecosystem engineers, plays a strategic role in the self-organizing process that accompanies soil function. At the taxonomic level of orders, the fifteen or so groups potentially present in all soils are familiar to farmers. Using data collected from 3,694 sites across 41 different countries, a global indicator was developed based

¹² Hurtado Lugo, E., Velasquez Ibañez, E., & Lavelle, P. (2024). A global indicator of soil macroinvertebrate community composition, abundance and diversity. *Applied Soil Ecology*, 193, 105138. <https://doi.org/10.1016/j.apsoil.2023.105138>



on parameters generated statistically. Universally applicable, it measures the abundance and diversity of the community on a scale of 0.1 to 1.0. In all the studies conducted, this indicator has been found to be significantly correlated with similarly constructed indicators of soil physical, biological, and chemical conditions, carbon storage, and greenhouse gas emissions. We conclude that the global macrofauna indicator (GMI)¹³ can be used by farmers to measure the environmental externalities of their practices. It therefore constitutes a valuable tool for **future public policies** that will consider the positive or negative value of externalities when determining their support.

3. Round Table: Framing and implementation of agroecological transitions, focusing on soil nexus. Round Table. Participants: Eduard Hernández Nualart (EC Via Campesina), Gunilla Andersson (Malmö local government), Francesca Ricardi (ERRIN), Jan Moudrý (University of Tomas Bata in Zlin), David Amudavi (Biovision Africa Trust), Emmanuel Petel, (DGAgri). Moderator: Marta Guadalupe Rivera Ferre (CSIC).

The round table brought together a diversity of actors, including actors with a role in decision-making (such as Gunilla Andersson from the Malmö local government and Emanuelle Petel, from DG AGR of the European Commission), farmers (Eduard Hernández from ECVC), researchers (Jan Moudrý from University of South Bohemia) and brokers (Francesca Ricardi from Free University of Bozen / Bolzano and David Amudavi from Biovision Africa)

Gunilla Andersson showed the important role municipalities can play in promoting agroecological transitions at local level through e.g. **public procurement** (At the city of Malmö, the schools offer 60% of **organic food**, with an expenditure of 20 million euros/year); **land ownership** (50% of agricultural land) and **land planning** of the city, including **contract conditions with farmers** and minimize exploitation of agricultural land in a context of high competition for other land uses (industry, building, energy, recreation, biodiversity conservation) and growing urban population (in Malmö about 3-5000 new citizens per year); **support of sustainable food business** (circular economy) and of civil society (first **food council** in Nordic countries).

Jan Moudrý (University of Tomas Bata in Zlin) discussed the complexity of finding **soil health indicators**. Science is often focused on biophysical Indicators but they may not be enough to support agroecological transition, since this requires a **holistic approach**, not fragmented indicators. He suggested that researchers need to provide the method to evaluate soil health from a more **complex (nexus) perspective**, and communicate this to practitioners.

Emmanuel Petel (DG Agri) discussed some **complementarities between CAP and Soil monitoring law**. Preservation of natural resources, including soil priority areas in future CAP include soil health (also biodiversity and climate issues). Mission Soil will decide on what intervention farmers will get support if they implement some actions. Prior farmers need to comply with conditionality, which include some standards linked to soil protection. The performance **monitoring framework of CAP** could include some **indicators from the soil law**. Also, from the national plans of Mission Soil, the European Commission can

¹³ Lavelle, Patrick. "Soil Macroinvertebrates, Actors and Indicators of Soil-Based Ecosystem Services." *Comptes Rendus Biologies*, vol. 1, no. 0, 2025, pp. 000–000. doi:10.5802/crbio.186.



assess where there are needs and the potential impact of Mission Soil implementation or CAP on soil health indicators. Mission Soil needs to provide **training to farmers**, including AKIS for dissemination. Through the soil mission, DG AGRI also expects to get better understanding of the relationship **between agricultural practices and soil health**.

Eduard Hernández Nualart (EC Via Campesina) stated that for agroecological farmers soil is not understood as a commodified, but is part of their identity. For them, we cannot talk about soil without talking about land concentration and the barriers for generational renewal. Despite ECVC was consulted in the development of the soil monitoring law their demands were not included. First demand is that soil law needs to include access to land and land tenure, as well as generational renewal. To take care of land, farmers need to have **secure access to land**. Particularly relevant for young farmers. Soil law should also include **restrictions to monoculture**. Also, the law does not mention the **root causes of land degradation**: monocultures, industrialization... and no limits are included to these root causes. Furthermore, it is not a binding law, limiting its potential benefits. Furthermore, he denounces that data from soil law will open space for **carbon trade and credits**, a compensation market that commodifies nature. They present another proposals to include in the future European directive on soil eg a **Fair democratic land practices** (land observatory) which will enable young farmers to access to the land through long term leases. For example, France gets **SAFER** which is a non-profit public-interest land management organisation. It helps allocate rural land to viable agricultural, environmental, or local-development projects in line with regional policies. it supports sustainable agriculture and helps young farmers to access land.

Francesca Ricardi (Free University of Bozen / Bolzano), explained the **major role of regions** in the second phase of the partnership and the importance of working in some EU networks such ERIAFF (EU Regions for Innovation in Agriculture, Food and Forestry – with an AE working group) and ERRIN (EU Regions Research and Innovation Network). Thanks to the active involvement in these networks, some Mission Soil projects could be mentioned such as: **SOILL** and **HuMUS** promoting soil health at local and regional level. In 2026, the Autonomous province of Bolzano will dedicate an important amount of funds to the setting up of a “**Land Register**”: all the south **Tyrolean Research Institutes** will be involved: samples, analyses and stockage of soil will help to create a soil bank. The Autonomous Province of Bolzano is also one of the co-funders of the 4 following partnerships: Biodiversa +, Agroecology, FutureFoods and FOREST. This gives the opportunity to local researchers to be involved in EU projects and enlarge their research networks.

David Amudavi (Biovision Africa Trust), explained that **soil health** is central in Africa to address **food security** and that changes in management are needed to stop mining the soil, not relying on chemical inputs and promote soil health.

- African countries are embracing a **policy -soil initiative** in Africa to reduce land degradation eg. **Nairobi declaration** call for policies that put soil health at the centre but also reduce chemical fertilizers to increase productivity through AE practices.
- **Plans of investments**. 10% investment in agriculture, to increase productivity of the sector by 6% (Kampala declaration)
- **Agroecology Programs: East Africa countries** are pointing national agroecology strategies that help to support, among other things, the question of soil health.
- **Performance indicators** also needed to make decisions and plan how long we want to be in transition.
- **Agroecological training** is agreed to be essential for soil health.

QUESTIONS

- One question entailed a general agreement from the Panel to understand **soil practices** from a **holistic perspective**.



- One question was raised about how to move farmers from conventional to agroecological considering also that chemical industry is fighting to discredit agroecology. For this purpose, we need to strengthen monitoring mechanisms including complex indicators to provide more evidence-based solutions relying on AE principles and communicate to practitioners and farmers.
- Finally, DG-AGRI presented current discussions around a **potential instrument** developed by the EU Commission to promote transition to resilient system for farmers based on a **lum sum for farmers engaged in long term advise for transition.**

4. Upcoming European Directive on Soil monitoring and Resilience by Mirco Barbero (DG Env)

Mirco Barbero presented the **future EU Directive on Soil Monitoring and Resilience**¹⁴, outlining its scientific rationale and regulatory implications. His talk emphasized the alarming state of European soils: **60–70% are considered unhealthy**, with widespread issues including erosion, compaction, organic matter decline, pollution, salinization, biodiversity loss, and accelerating land take. M. Barbero noted the measurable economic and environmental impacts, such as **1.25 billion euros of annual crop losses** from erosion, **7.4 million tonnes of CO₂ emitted yearly** from degraded cropland soils, and **390,000 contaminated sites** requiring remediation across the EU. These figures underscore the need for a coordinated legislative response.

M. Barbero situated the Directive within the broader framework of the European Green Deal, the EU Biodiversity Strategy, and the EU Soil Strategy, recalling the EU's objective that **all soil ecosystems should be healthy by 2050**¹⁵. The Directive operationalizes this goal by establishing a harmonised monitoring framework based on soil districts, standardised soil health descriptors, and common criteria for degradation assessment. Monitoring will rely on integrated datasets and tools—including the **LUCAS soil survey**, **Copernicus remote sensing**, and the **EU Soil Observatory (EUSO)**—coordinated through an EU-wide digital soil data portal. These measures aim to bring coherence to currently fragmented national soil monitoring systems and ensure comparable, transparent soil assessments across Member States. In his presentation, M. Barbero also highlighted new obligations for Member States, such as the requirement to identify degraded areas, support land managers through advisory services and training, and promote public participation in soil governance. For **contaminated sites**, the Directive introduces a **risk-based approach** demanding investigation, risk assessment, and targeted remediation, supported by publicly accessible registers. Addressing another major driver of soil degradation, M. Barbero stressed the need to mitigate land take and soil sealing, particularly since **78% of land take affects agricultural soils**. The Directive therefore introduces principles to minimise new sealing and encourages compensatory restoration measures, while still respecting national planning autonomy.

M. Barbero concluded by describing governance and reporting requirements, including regular electronic reporting, transparency provisions, and mechanisms for evaluation and enforcement. Overall, his talk presented the future Directive as a transformative policy instrument that integrates scientific evidence, harmonised monitoring systems, and risk governance to safeguard soil functions. The Directive, as outlined, seeks to strengthen climate resilience, protect biodiversity, enhance food security, and ensure the long-term sustainability of European landscapes.

¹⁴ European Commission. *Proposal for a Soil Monitoring Law (2023)*.

¹⁵ European Commission. *EU Soil Strategy for 2030*.



5. Breakout session: Impacts of the future European soil law at the local level, including users' impacts", by Rainer Baritz (European Environment Agency), moderators: Hubert de Jonge and Theo Paquet

Number of participants 11: here among stakeholders 4; research 4; policy 3

Rainer Baritz from the European Environmental Agency opened the discussion with an introductory presentation on the impacts of the future European Soil Law at the local level. He emphasized that farmers and practitioners are not directly covered by the law itself, yet they are the ones who can support achieving its objectives by improving soil conditions. A major strength of the Soil Monitoring Law (SML) approach, according to him, is its ability to provide objective data that accounts for regional and landscape differences. This is critical for convincing practitioners in a fair way. Farmers will be able to compare their field's soil health with regional benchmarks, moving away from rigid top-down measures where every farmer must comply in the same way. Instead, this approach gives the initiative for environmental stewardship back to farmers. Baritz stressed the importance of interpreting monitoring results against clear thresholds. Currently, the law focuses on monitoring trends without defining what is considered acceptable. Without thresholds, the actual impact of monitoring will remain limited.

The discussion then moved to the types of soil indicators, which were categorized into three groups: chemical indicators, which change slowly; physical indicators, which also change slowly; and biological indicators, which change very rapidly and reflect the present dynamic state of the soil. Participants noted that while improvements in soil health for the first two occur gradually, degradation can still happen very quickly. This temporal dimension highlights the need for timely interventions when early signs of degradation appear.

Attention then turned to the complementarity of different approaches to soil monitoring, illustrated by a slide on water and habitat degradation. Participants noted that this complementarity is essential because soil conditions are shaped by multiple factors that interact over time. Practitioners often react strongly to quantitative data, partly because soil has a "long-term memory." Farmers frequently work on land with historic degradation, which is difficult to compensate for, making interpretation of monitoring results particularly sensitive. This underlines the need for caution when translating data into recommendations and policies that help bridge the gap between observed soil conditions and current practices.



Policy design was highlighted as a way to make information accessible and improve understanding of ecosystem services. However, existing thresholds mostly focus on productivity, leaving broader impacts of soil health indicators underrepresented. This is further compounded by the lack of clear thresholds, as monitoring trends alone cannot define what is acceptable or critical (cf. Slide EEA (2022)¹⁶: current existing thresholds). To address

EEA (2022): currently existing thresholds

- Land use specific
- Soil-specific

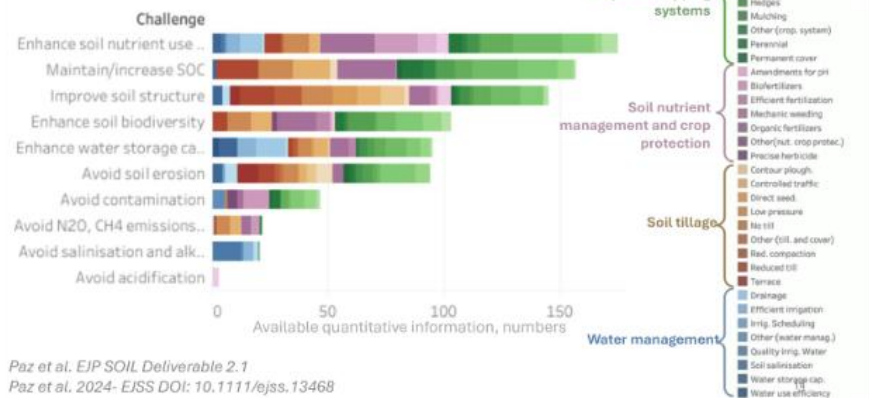


this gap, participants discussed the value of a risk-based approach. They agreed it would be essential in creating a common language with farmers at the local level and for making monitoring results actionable.

The role of practitioners and farm advisors emerged as a critical theme. Farm advisors are key to translating technical knowledge into actionable steps for farmers. However, the current knowledge base (cf. Slide Contribution of sustainable soil practices to soil challenges) lacks sufficient context for farmers. Breaking this information into recommendations for advisors is essential, and the Soil Monitoring Law could serve as a foundation for this process and initiate a dialogue on the local level. These recommendations are in the opinion of Baritz to be challenged by local advisors to improve the implementation of local solutions for sustainable soil management.

Contribution of sustainable soil practices to soil challenges: an EU analysis of available knowledge

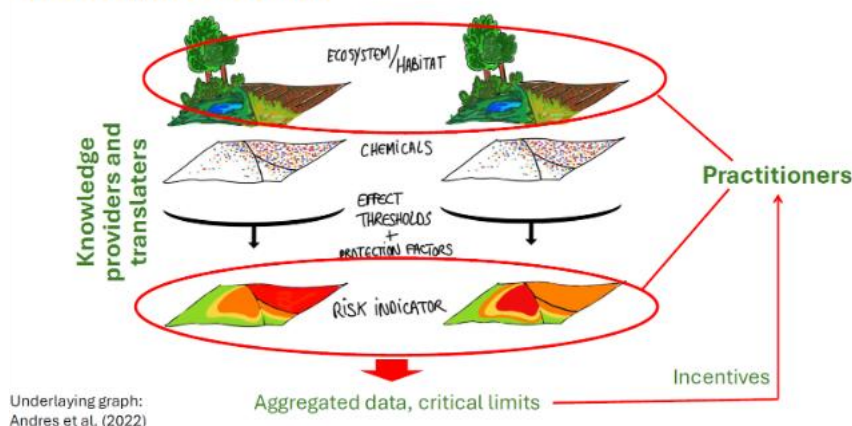
Slide by Chenu et al. 2024



Paz et al. EJP SOIL Deliverable 2.1
Paz et al. 2024- EJSS DOI: 10.1111/ejss.13468

¹⁶ Environmental Statement report 2022, 58p, European Environment Agency, Copenhagen Denmark..

Role of practitioners



To illustrate this point, the “Role of Practitioners” slide was presented. It shows how practitioners act as intermediaries between scientific data and practical application. At the top level, ecosystem and habitat conditions are linked to chemical indicators and thresholds, which then feed into risk indicators. Practitioners are positioned as both knowledge providers and translators, ensuring that complex data is interpreted correctly and communicated in a

way that farmers can act upon. The diagram also highlights the importance of aggregated data and critical limits, which underpin incentive systems. This reinforces the idea that practitioners are not only technical advisors but also key actors in connecting monitoring results to policy instruments and farmer decision-making.

The need for all information to be channeled through farm advisors was reiterated. An additional point raised was that when implementing greening measures, notably in the Common Agricultural Policy, the indicators used differ from those in soil monitoring, highlighting the importance of cross-communication.

Evidence linking soil contamination and human health was briefly addressed during the discussion. Most of the evidence base is from contaminated sites, and while some evidence exists for rural areas e.g. a Dutch study on pesticide exposure through domestic dust, the general knowledge base for agricultural soils remain limited. Participants suggested going beyond risk-based approaches to address the full range of soil issues, rather than focusing narrowly on contamination or productivity.

The conversation then turned into contamination concerns, illustrated by a slide on metals. This led to a broader policy discussion: the now-deleted Chapter III of the Soil Monitoring Law was seen as an opportunity for the European Soil Partnership to develop regional-level guidelines. Such guidelines could inform policy development at a more granular level, rather than concentrating solely on farm-level measures.

The possibility for development of a single unifying soil health monitoring index was discussed. No such index is currently developed, and the development would be dependent on weighing different criteria. Reference was made to the “one out, all out” principle, as used in the Water Framework Directive (WFD). This principle ensures that no single criterium is neglected/ignored and avoids that relying on a single index would obscure important details. Therefore, the soil monitoring law does require monitoring of all different criteria, thus providing meaningful data to practitioners, on which they can base local targeted remediating actions. The approach is high data-density, and it was mentioned that remote-sensing data makes even high-resolution mapping and modelling possible, that again potentially can serve to assist local targeted measures.

Farm-level challenges were discussed extensively. Farmers often receive data without clear links to their practices, leaving them uncertain about what actions to take. A proposed solution was to establish a feedback system at the local level, where farmers collect data and receive actionable insights tied to their



practices. Incentives could then be introduced based on this system. Participants also noted that precision farming maps currently lack prescriptive guidance, and farmers expressed fear of penalties and excessive control.

A shift toward self-evaluation and capacity-building was suggested as an alternative policy philosophy. Several participants argued that incentives should replace penalties. However, current incentives tend to focus on farming practices rather than monitoring systems or training. Farmers struggle to manage and interpret their data, reinforcing the need for advisory support. Mirco added that precision agriculture does not measure SML indicators. Efforts to introduce soil health certificates into law were unsuccessful, but voluntary adoption remains possible and can be of value for farmers e.g. good soil health would support the economic value of their land.

Technical concerns were also raised regarding metal accumulation in the context of ecosystem functions – e.g. copper is a micro-nutrient and cadmium is not, and metals can be bioavailable or not depending on e.g. chelation. Hence, it was suggested that the coupling of concentration to risk for humans needs to be considered. The discussion highlighted the importance of balance maps, which can be applied at farm level to track inputs and outputs. Current metal balance data show that all metals are accumulating over time at the farm level, raising concerns about critical loads and long-term soil health.

Current monitoring practices vary significantly across Member States. Some countries, such as the Netherlands and Portugal, provide strong support for soil monitoring, while others offer little assistance. Small-scale farmers often lack knowledge about subsidies and soil sampling opportunities. The CAP allows for subsidizing soil sampling, and the soil strategy includes initiatives such as “test your soil for free” while soil sampling guidelines are in the preparation phase.

Looking ahead, participants identified some promising avenues for innovation. One idea was to integrate soil monitoring factors into precision agriculture machinery, making data collection more seamless. Spatial and temporal aspects were also discussed: certain indicators, such as organic content in topsoil and macrofauna, change relatively quickly. Agroecological measures can produce rapid improvements in SML indicators, which should be leveraged in policy and practice.

The discussion concluded by identifying two distinct dimensions of soil measurement: the dynamics of ecosystem service production and contamination, which should be treated separately in monitoring and policy frameworks. Baritz concluded by saying that detailed knowledge of soil properties and its relation to processes, soil functions, soil function indicators, and practices currently cannot be extracted from research projects.

6. Breakout session: “Show cases at the regional level” speaker Dr Rachel Cassidy, Agri-Food and Biosciences Institute (AFBI), moderators Emmanuelle Cariou, ANR and Gabriele Ridolfi, FIBL)

Context and Objectives

The session aimed to present and discuss concrete examples to inspire the implementation of the Soil Monitoring Law (SML) at regional or national scales, exploring how these experiences could inform the interpretation and implementation of the forthcoming EU Directive on Soil Monitoring and Resilience.

Dr. Rachel Cassidy, from the Agri-Food and Biosciences Institute (AFBI, Northern Ireland), presented the **Northern Ireland Soil Nutrient Health Scheme (SNHS)**, [Soil Nutrient Health Scheme | Agri-Food and](#)



[Biosciences Institute](#)), an **ambitious regional programme** that has become a leading example of **landscape-scale soil and nutrient monitoring in Europe**.

Summary of Presentation – Northern Ireland Soil Nutrient Health Scheme

Dr. Cassidy introduced the Soil Nutrient Health Scheme (SNHS), a national-scale initiative coordinated by AFBI (Agri-Food and Biosciences Institute) under the Department of Agriculture, Environment and Rural Affairs (DAERA). The Scheme represents the largest soil sampling and analysis programme ever undertaken in Northern Ireland, with the objective of sampling every actively managed field on every farm by 2026. The programme's purpose is to create a comprehensive soil and nutrient baseline for the entire agricultural landscape, aiming to enhance nutrient management on farms, provide a baseline for carbon accounting, and deliver improved environmental performance.

The SNHS was conceived to address major challenges in soil and water quality management. Over 70% of rivers in Northern Ireland are below good ecological status, largely due to phosphorus enrichment. Agriculture contributes approximately 60% of the nutrient load to surface waters, mostly through diffuse runoff from overloaded soils rather than direct farmyard losses¹⁷. Dr. Cassidy noted that prior to SNHS fewer than 10% of farmers had regularly soil tested, leading to widespread inefficiency in nutrient use, low soil pH, and often excessive use of chemical fertilisers.

The government committed £45 million (approximately €50 million) to implement the Scheme over 2022–2026. Its design followed years of preparatory work, including the 2016 Sustainable Agri-Land Management Strategy report¹⁸ and subsequent pilot studies covering 30,000 fields. These pilots revealed significant knowledge gaps among farmers and informed the final structure of the SNHS. The scheme now serves as both a monitoring instrument and a vehicle for farmer engagement and behavioural change.

Operationally, soil samples are collected to an AFBI protocol by a professional contractor (RPS Group), ensuring methodological consistency. Around 150 trained samplers work across four geographic zones, one zone per year (2022-26). Each field is analysed for a suite of indicators including pH, phosphorus, potassium, magnesium, calcium, sulphate, and organic matter. Samples are processed at NRM Laboratories in England, and results are made available to farmers within 4–6 weeks by post or email, and subsequently uploaded to an online mapping portal. The system also links through to an obligatory training programme for farmers and links to online tools to generate nutrient management plans and calculate crop nutrient requirements.

A distinctive element of the SNHS is the integration of high-resolution spatial data. The entire territory of Northern Ireland has been surveyed using LiDAR at 16 points per metre, enabling detailed mapping of topographic wetness, runoff risks, and carbon stock estimates in above ground biomass. The data combine soil characteristics and hydrological modelling to generate runoff risk maps, which guide farmers in identifying zones unsuitable for fertiliser or slurry spreading and where options should be considered to break connections between land and water (e.g. buffer strips). Each participant farm receives a set of digital maps with traffic-light colour coding for all nutrients (green = optimal, yellow = caution (potentially low), red = high), as well as recommendations for nutrient management based on the crop information they register and with strict exclusion of recommendations for amendments in any environmentally sensitive areas.

The Scheme's strong link with environmental policy and data integration supports multiple objectives: to reduce nutrient losses to water, improve fertiliser efficiency, build carbon inventories, and support new sustainable farming payment schemes. Participation in the SNHS is mandatory for farmers wishing to access farm sustainability schemes with-in the new Sustainable Agriculture Programme, which replaces the

¹⁷ *Water Framework Directive, Statistics Report, 42p, 2021.*

¹⁸ *Delivering Our Future, Valuing Our Soils :A Sustainable Agricultural Land Management Strategy for Northern Ireland, 135p, 2016.*



single farm payment. As a result, registration has reached 93% of all eligible 26,000 Northern Irish farms—covering more than 600,000 fields.

Dr. Cassidy stressed the **dual dimension of the programme**: a **service for farmers** and a **scientific platform for policy**. For farmers, it provides **practical management tools, training** (delivered by CAFRE – College of Agriculture and Rural Enterprise), and **on-farm feedback on nutrient and carbon status**. For policymakers, it delivers a **national baseline to guide the Nitrates Action Programme** (in NI known as the Nutrients Action Programme), nutrient redistribution policies, and **future soil legislation**. The SNHS thus bridges the gap between environmental regulation and farmer-level data, with strong potential relevance for the European Soil Law.

The presentation also **highlighted challenges**. Despite high registration rates, only around 7,000 of the 18,000 participating farmers sampled to date had completed the mandatory training. Connectivity issues and limited digital literacy were major **obstacles to online participation**. The project team (DAERA/AFBI/CAFRE and including researchers at Leeds University) are exploring hybrid models—combining in-person and thematic group training—to foster peer learning and increase uptake. The behavioural change aspect remains central: shifting decision-making from **dependence on fertiliser or feed companies to informed management based on soil evidence**. Phase II of the SNHS, planned after 2026, will hopefully expand into **physical and biological assessments** to complement chemical monitoring.

Key Discussion Points

- **Training and knowledge exchange**: Participants discussed the need for bottom-up approaches and farmer-to-farmer learning. Models such as farmer field schools and **lighthouses** were proposed as inspiration.
- **Data sharing and confidentiality**: Farmers' trust hinges on strict data ownership guarantees; field-level data remain confidential.
- **Generational renewal**: Questions arose on youth engagement and digital skills; education rather than age was identified as the key factor.
- **Policy alignment**: Participants reflected on how the scheme could inform the European Soil Law, particularly regarding the **definition of 'soil managers'**.

7. Breakout session: added services of the Soil Monitoring Law, mitigating climate change: how do we enhance carbon sequestration following the AE principles, (speaker Cornelia Rumpel, INRAE, moderator Jan Mouldry, Karim Jouhari, IFOAM)

Summary of Presentation – mitigating climate change: how do we enhance carbon sequestration in soil, principles, trade-offs and the holistic approach to maximize the level of Soil Organic Matter

Soil carbon sequestration has emerged as a **key strategy in addressing climate change** while simultaneously improving soil health. According to Cornelia Rumpel, soils are complex ecosystems whose functioning depends on the interaction of physical, chemical, and biological processes. Central to these processes is **soil organic matter (SOM)**, which regulates most soil functions and ecosystem services. The concept of soil health encompasses the soil's ability to sustain plant productivity, maintain environmental quality, and promote biodiversity. Because SOM directly influences soil structure, nutrient availability, and microbial activity, its management is critical for sustainable land use¹⁹.

¹⁹ Harris, J., et al. (2022). *Soil health and soil biodiversity: linking soil biota to ecosystem services*. *European Journal of Soil Science*.



- **Role and Benefits of Soil Organic Matter.** Enhancing soil organic matter provides multiple benefits across soil functions. Physically, SOM improves soil aggregation, increases water infiltration, and enhances water holding capacity, thereby reducing erosion and improving resilience to extreme climatic events. Biologically, it acts as a reservoir of nutrients such as nitrogen and phosphorus and supports microbial life, which is essential for nutrient cycling and plant growth. Chemically, SOM contributes to cation exchange capacity, buffers soil pH, and helps control pollutants.

As highlighted by Cornelia Rumpel, increasing soil organic carbon (SOC) stocks can lead to higher agricultural productivity, enhanced biodiversity, and greater resistance to environmental stress. Consequently, SOC sequestration has been proposed as a co-benefit strategy for both climate change mitigation and adaptation ²⁰.

- **Soil Carbon in the Global Climate System:** Soils represent the largest terrestrial carbon reservoir, containing approximately 2400 gigatons of carbon, which is three to four times more than that stored in vegetation or the atmosphere ²¹. This makes soils a crucial component of the global carbon cycle. However, European soils are currently acting as net carbon sources due to degradation and intensive agricultural practices. SOC losses have been estimated at around 0.75% of total stocks, corresponding to approximately 70 million tons of carbon ²². These losses contribute to greenhouse gas emissions and exacerbate climate change. Despite this, soils have the potential to function as carbon sinks if appropriate management practices are implemented in fields. **Even small increases in SOC stocks could significantly influence atmospheric CO₂ concentrations** ²³. The annual greenhouse gas emissions from fossil carbon are estimated at 8.9 giga tonnes C (8.9×10^{15} g), and a global estimate of soil C stock to 2 m of soil depth of 2400 giga tonnes (2400×10^{15} g). Taking the ratio of global anthropogenic C emissions and the total SOC stock ($8.9/2400$), results in the value of 0.4% or 4‰ (4 per mille). **Increasing SOC has been proposed to mitigate climate change with an additional benefit of improving soil structure and conditions.**

- **Challenges and Trade-offs:** Although soil carbon sequestration offers promising benefits, it is not without limitations. The process requires sufficient inputs of organic matter, water, and nutrients such as nitrogen and phosphorus. Furthermore, certain conditions, particularly anaerobic environments, may lead to increased emissions of methane (CH₄) and nitrous oxide (N₂O), which are potent greenhouse gases. **Changes in agricultural practices adopting Agroecology principles** are often necessary to achieve meaningful results. Indeed, the current intensive agricultural model, characterized by heavy machinery use, high agrochemical inputs, and periods of bare soil, has led to widespread soil degradation and carbon loss. In contrast, an agroecological approach promotes sustainable practices such as permanent soil cover, crop diversification, reduced external inputs, and circular resource use. According to Rumpel et al.²⁴, such practices **can enhance soil organic matter accumulation and reduce CO₂ emissions.**

- **Soil carbon sequestration** is governed by complex interactions between plant inputs, microbial processes, and mineral associations. In the short term, the decomposition of plant residues depends on their chemical composition and environmental conditions. In the long term, carbon stabilization occurs through **processes such as aggregation** and the formation of mineral-associated organic matter (MAOM).

²⁰ Soussana, J.-F., et al. (2019). *Matching policy and science: Rationale for the '4 per 1000 – soils for food security and climate' initiative.*

²¹ Minasny, B., Malone, B. P., McBratney, A. B., et al. (2017). *Soil carbon 4 per mille. Geoderma.*

²² De Rosa, D., et al. (2024). *Soil organic carbon losses in European agricultural soils and their implications for climate change. Global Change Biology.*

²³ Balesdent, J., & Arrouays, D. (1999). *An estimate of annual carbon input to soil in France from crop residues.*

²⁴ Rumpel, C., et al. (2022). *Soil carbon and soil security in the context of climate change and sustainable development. Soil Security.*



These processes operate across multiple spatial scales, from microscopic interactions to landscape-level dynamics. As a result, **understanding SOC sequestration requires a holistic and integrated approach** ²⁵.

- **Importance of Biodiversity:** Soil organisms play a fundamental role in maintaining soil health by supporting processes such as decomposition, nutrient cycling, and soil structure formation. Soil biodiversity has been shown to enhance soil multifunctionality. In addition, plant diversity positively influences SOC storage by increasing carbon inputs and stimulating microbial activity ²⁶. **Agroecological practices** such as intercropping, cover cropping, and agroforestry exploit these biological interactions to improve both productivity and environmental sustainability.

In conclusion, soil carbon sequestration represents a valuable strategy for addressing climate change while improving soil health and agricultural sustainability. However, it is not a standalone solution and must be integrated into a broader agroecological transition. As emphasized by Cornelia Rumpel, **a holistic understanding of soil systems**—encompassing biological, chemical, and physical processes—is essential for **designing effective management strategies**.

Key Discussion Points:

- Future efforts should focus on **improving soil monitoring**, understanding the links between soil properties and ecosystem services.
- Fostering collaboration among stakeholders to implement sustainable and Agroecology practices and principles is a key point in achieving **Soil carbon sequestration as a leverage to mitigate the climate change**

8. Outlook – Agroecological Transitions with a Focus on soil and land management

²⁷

The 2nd EPAT highlights that soils are central to agroecological transitions, linking environmental, economic, and social dimensions. This systemic “soil nexus” perspective emphasizes the need to connect soil science with legal and governance frameworks.

Current policies, including the CAP and emerging EU Soil Directive, show progress but remain fragmented and insufficient to support full agroecological transitions. Both EPAT findings and Albias et al. stress that stronger science–policy interfaces are needed to translate soil knowledge into effective and coherent policy action.

A key challenge is soil health measurement. While many indicators exist, they are not yet fully operational for decision-making. Moving from monitoring to actionable thresholds and farmer-oriented tools is essential to make soil data useful in practice and policy.

The upcoming EU Soil Monitoring and Resilience Directive represents an important step toward harmonised monitoring, but its non-binding nature and limited integration of social issues (e.g. land access) may restrict its impact.

²⁵ Vogel, H.-J., et al. (2021). A holistic perspective on soil structure and its role in soil functioning. *European Journal of Soil Science*.

²⁶ Lange, M., Eisenhauer, N., Sierra, C. A., et al. (2015). Plant diversity increases soil microbial activity and soil carbon storage. *Nature Communications*.

²⁷ Possibly for this outlook, mention Albias et al, 2025 *Bridging Law and Soil Science to Promote Soil Health*



At the local level, implementation remains a major bottleneck. Farmers need clearer guidance, better advisory systems, and incentives rather than penalties. Successful examples, such as large-scale monitoring schemes, show the importance of combining data, training, and policy support.

Agroecological transitions also require integrating environmental externalities into economic systems. Policies should reward positive soil functions and support farmers during transition phases.

Finally, soil governance must address broader social and political dimensions, including land tenure, generational renewal, and equity, as also highlighted by Albias et al..

Overall, achieving healthy soils by 2050 will depend on better integration of science, policy, and practice, supported by holistic, locally adapted, and socially inclusive approaches.

Main takeaways / recommendations: From the break-out sessions:

- Farmers need **to be able to access the data** generated by the Soil Monitoring Law, and they should be supported in using it. This will need to **include incentives** – notably via the Common Agricultural Policy, which already allows support for soil sampling – and advisory services – e.g. **AKIS and independent advisory services**.
- **Once soil monitoring indicators** have been developed further by Member States and Regions, these should be integrated in the **development of sustainable management practices**, hereunder precision agriculture – mapping & machines.
- There should be a **feedback loop** from farmers backwards towards Regions and Member States.
- Indicators should be leveraged to create new markets for farmers: for example, through voluntary **soil health certificates**.
- Legislation should move away from restrictions/conditions to incentives.
- Consider the temporal dimension of indicators when designing advice and markets: biological indicators change rapidly, while chemical and physical indicators improve slowly but can degrade quickly. This must be reflected **in farmer guidance and market mechanisms** that are targeted at local and context-specific conditions.
- The **pace of agroecological transitions** is also determined by **biological processes**. More specifically, the formation of organo-mineral fractions²⁸ can also be stimulated and balance dynamic/instable C with indirect consequences on mitigation of climate change.

In conclusion, the soil nexus offers a powerful entry point for advancing agroecological transitions in Europe. The coming years will be decisive in determining whether the combination of monitoring systems, policy instruments, and stakeholder engagement can effectively transform soil knowledge into practice. Achieving this will require a systemic approach that connects data to decisions, incentives to practices, and ecological processes to governance frameworks.

²⁸ Song et al, 2025. *The role of earthworms in the transformation of labile plant litter into mineral-associated organic matter. Soil Biology and Chemistry.*