

WHITE PAPER

**SOIL HORIZONS:
UNEARTHING
PERSPECTIVES ON
THE FUTURE OF SOIL
CARBON GOVERNANCE**

Part 1: A Surface Outlook

October 2023

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CONTENTS

EXECUTIVE SUMMARY	3
INTRODUCTION	5
• Scientific literature review.....	5
• Political landscape summary	6
RESULTS SUMMARIES	10
• Issues facing European land stewards.....	11
• Debating the role of land stewards in EU climate action.....	12
• Soil carbon MRV: State of play and future potential in Europe.....	14
• Imagining the EU's climate-friendly farming transition.....	16
• Soil transition in practice: Interviewees' policy propositions	18
CARBON GAP'S TAKE	19
• Framing the challenge of soil carbon governance to policy-makers.....	20
• A three-tiered approach to soil carbon governance	20
• Ensuring safe, effective and just soil health governance.....	22
ACKNOWLEDGEMENTS	22
REFERENCES	23

List of Abbreviations

AECM	Agri-Environment and Climate Measures
CAP	Common Agricultural Policy
CDR	Carbon Dioxide Removal
CRCF	Carbon Removal Certification Framework
ECL	European Climate Law
ESDAC	European Soil Data Centre
ETS	Emissions Trading Scheme
EUSO	EU Soil Observatory
GAEC	Good Agricultural and Environmental Conditions
GHG	Greenhouse Gas
IACS	Integrated Administration Control System
LULUCF	Land-Use, Land-Use Change and Forestry
MRV	Monitoring, Reporting and Verification
NECP	National Energy and Climate Plans
NRL	Nature Restoration Law
RS	Remote Sensing
SIS	Soil Information System
SML	Soil Monitoring Law
SOC	Soil Organic Carbon
SOM	Soil Organic Matter
VCM	Voluntary Carbon Markets

Executive summary

As the next electoral cycle dawns, the European Union faces interconnected climate, biodiversity, and soil crises. Big decisions lie ahead. **Soil stakeholders debate how best to reverse worrying degradation trends; some prefer regulatory measures whereas others champion market-oriented policies.** The EU is currently considering many different approaches, such as the [Soil Monitoring Law](#)¹ and the [Nature Restoration Law](#)². There is also discussion on whether soil carbon should be “unitised” and traded in an [Emissions Trading Scheme specific to the land and agricultural sector](#)³, or certified through the [EU carbon removal certification framework](#)⁴. Given the entwinement of soil and climate outcomes, the stakes are high for Europe to act wisely and achieve coherence across its soil governance.

So far, **the EU and many of its member states rely heavily on nature-based removal pathways for their net zero targets**⁵. These pathways are typically perceived as cheap, easy to deploy, widely beneficial and accepted by the general public, which makes them attractive to policy-makers. The use of soils as carbon sinks was particularly popularised during COP21 with the advent of the [4p1000 initiative](#)⁶.

But nature-based removal pathways have limitations. Some of these limitations are well known, such as the fragility of soils’ carbon stock which entails low durability storage. Other limitations are less well popularised, such as the notion that biospheric carbon sinks should not be used to counterbalance fossil emissions since they entail different pools within the carbon cycle. This idea is paramount in the concept of [durable net zero](#)⁷.

In addition, considering the limited soil reserves that underpin food production, water maintenance, terrestrial ecosystems, land steward lifestyles and many services besides, to what extent should soil be viewed through the climate regulation lens and commandeered for mitigation efforts?

As an NGO advocating for the principled scale-up of carbon dioxide removal (CDR) methods, Carbon Gap has undertaken an investigation into soil as a key variable of the CDR equation in acknowledgement of the uniquely complex trade-offs involved in land-based management approaches. Our aim is to enrich discussion by disentangling debates and highlighting potential ways forward.

To that end, we interviewed fourteen experts across a diversity of perspectives, from farmers’ unions to civil society watchdogs to soil carbon specialists. These interviews complemented a review of the science and political landscape.

Interviewees discussed the role they think soil carbon (and land stewards more broadly) should play in EU climate mitigation efforts.

A collective list of dos and don’ts emerged, albeit with significant areas of disagreement. In this paper, we present our key findings and explain the positions Carbon Gap has reached, with the understanding that this space is fast-evolving, both politically and technologically, requiring nimble advocacy.

EU land is in critical condition and the Union has not yet managed to turn the tide on land degradation. With climate change accelerating and unleashing its impacts, the EU must rapidly restore soil health both for mitigation and adaptation purposes.

To instigate this transition, Carbon Gap proposes three high-level recommendations: mandatory requirements for member states, tailored transition pathways for farmers, and regulated private sector involvement. This multi-layered approach can help Europe maintain minimum soil health levels, kickstart an inclusive mass movement of change among land stewards, and crowd in private investment to distribute the burden of change, respectively. Although these components are stackable, the EU should not overlook the importance of legally-binding targets to complement voluntary schemes.

Enforcing Union-wide requirements will **entail harmonisation of soil data collection processes across member states and an appropriate level of monitoring, reporting and verification (MRV) to track progress.**

European land management is at a crossroads defined by multiple needs and mounting challenges. Any governance that emerges around soil carbon must take account of this complexity. To that aim, **we propose looking through the lens of doughnut economics at soil policy, defining a “safe, effective and just space”** for EU efforts to operate within. This approach, distilled through interviewees’ collective recommendations, clarifies a social foundation that must not be transgressed and a socio-ecological ceiling that must not be exceeded by soil carbon governance outcomes.

Within this safe governance space, tailored farmer transition pathways must be pursued, reflective of their different priorities, levels of responsibility and capacity to transition. We review different approaches for catalysing large-scale change in land stewardship and explore how these can combine in a tiered framework. We also review **MRV options**, highlighting promising new areas of research, technological bottlenecks, and noting the need to match costs with the benefits derived. Ultimately, to ensure urgent action is not delayed, it is essential to reduce the dependency of soil carbon restoration efforts on developing mature MRV tools.

Alongside binding targets, tailored transition pathways and regulated private sector engagement, we also highlight the need for the EU to review and phase out the perverse incentives that are still pushing land stewards to manage soils unsustainably.

Ultimately, because soil restoration is so strategic to prioritise, **the EU should seek to maximise control over its trajectory towards soil health targets**, achieving the bulk of its targets through publicly driven measures. Also, since the fate of soils depends on broader trends, explicitly linking EU soil health policy with food management and international trade is essential.

This research also shows that the **risks, implications and costs of investing in soil carbon as a climate change mitigation strategy are likely underestimated**, and limitations such as the speed of adoption of new practices among a shrinking, ageing land steward population are overlooked. Therefore, **Carbon Gap recommends that the EU not over-rely on soil carbon to meet its climate objectives** and further recommends that it accelerate the deployment of alternative CDR approaches with reduced land-footprints to alleviate the stakes on soil carbon and leave more room for soil health.



Introduction

European soil carbon governance is contentious. **Political debates reflect the dual nature of soil as a public good and a private resource,** as well as its multi-faceted value as an ecosystem servicer. Soil's foundational role in sustaining agricultural production, biodiversity and multiple ecosystem functions means its fate is linked to the prosperity of all and the personal wealth of few.

Scientific debates on soil carbon are just as vibrant and, at times, polarised. New research and technologies constantly enter the fray, attempting to overcome long-standing mysteries and bottlenecks.

The urgency to resolve political tensions and scientific questions stems from the fact that Europe's soils are in dire straits. Currently, EU soils are a net source of carbon, losing more carbon than they gain. Soil as a net carbon source contributes to the land [degradation that affects two-thirds of EU land](#)⁸; 6% of EU agricultural land is severely eroded, [25% has erosion rates above the recommended threshold](#)⁹, and at least [25% of European land has been identified as at high or very high risk of desertification](#)¹⁰. These trends are driven by unsustainable land management practices, including cultivation and drainage of organic soils, costing the EU [several tens of billions of euros per year](#)¹¹.

Europe must take decisive action to stop its soils further degrading and exacerbating the climate crisis. According to the European Commission, the cost of inaction [would be six times that of action](#)¹¹. With this imperative in mind, Carbon Gap reviewed both the scientific literature and the political landscape to inform its advocacy on soil's behalf.

Scientific literature review

Scientists acknowledge the ["contradictory scientific opinions on soil carbon storage"](#)¹² that span empirical and methodological questions. Specifically, scientists debate the mechanisms that lead to carbon accrual in soils and how those mechanisms control organic carbon dynamics thereafter. Active areas of discussion include:

1. What makes soil organic matter persist in the soil? For decades, scientists have proposed theories attempting to explain soil organic matter (SOM) persistence¹². Theories include chemical recalcitrance, microbial stoichiometry, energetic yield, aggregation, association with minerals, and microbial transformation. These older theories suffered from methodological limitations and biases and, although they have not been invalidated by recent progress, have been shown to provide a smaller part of the overall picture than previously thought. Scientists now contextualise the intrinsic properties of organic matter amidst an array of biotic and abiotic environmental parameters affecting soil dynamics.

2. What are the respective roles of plants and microbes in the production of persistent soil organic matter (SOM)?

The molecular composition of persistent SOM, of which carbon is the main constituent, provides an insight into its origins. It was long supposed that plants provided the slow-to-degrade organic matter, but [recent studies suggest that microbial compounds contribute significantly](#)¹².

3. How to calculate the carbon sequestration potential of various soils across multiple timescales?

Scientists debate which factors to prioritise or even include in carbon sequestration calculations, reflecting conflicting views on the relative importance of plant debris inputs versus mineral composition of the soil. Relatedly, there is also discussion on how best to monitor, report and verify (MRV) changes in soil carbon content over time, with scientists exploring both direct and inferred measurement techniques. [All approaches have benefits and drawbacks](#)¹³, from conventional lab-based techniques to emerging approaches that deploy infra-red sensing.

4. What should the role of "big data" be in monitoring soils?

The collection of soil data across large spatial scales can provide insights that are either too expensive or time-consuming to do experimentally. Big data could help [monitor changes in soil carbon stocks, predict soil carbon dynamics and better understand soil functioning](#)¹². However, processing and interpreting this data is skills-intensive, and the varied quality of data inputs may undermine the veracity of results.

5. How much do various land management practices contribute to climate change mitigation?

The climate benefits of practices can [vary depending on soil characteristics](#)¹², and their long-term impacts on soil quality and climate mitigation are uncertain. One scientific review found that most regenerative agricultural management practices were ["not likely to lead to a large net sequestration of organic carbon in soils"](#)¹⁴. [Debate continues around the impact of specific agricultural practices such as no-tillage land preparation](#)¹⁵, which, though widely thought to be positive for soil quality and crop growth, may be less effective than previously considered at mitigating climate change through organic carbon sequestration. This likely reduction in the efficacy of no-till is because the increase in soil organic carbon (SOC) under no-till may reflect a redistribution of carbon towards the topsoil, rather than a net increase across the entire soil profile. Additionally, [SOC sequestration will not be long-term](#)¹⁵ if farmers switch from no-till to conventional tillage, and the rate of SOC increase will decline as saturation is approached anyhow.

6. How much carbon can be stored in agricultural soils around the world?

Estimates of additional SOC that could be stored on croplands globally vary depending on the underlying methodological approach. Such estimates are needed for policy-makers to design effectual climate change mitigation policies, since larger estimates lend themselves to more assertive policies, whereas [smaller estimates suggest efforts are better placed elsewhere](#)¹⁶.

Methodologies vary in their assumptions, complexity and uncertainty levels. Some scientists maintain that [existing topsoil carbon stocks can simply increase by a constant fraction of 0.4% each year](#)¹⁷. Others argue that it's [better to estimate future soil carbon gains in terms of partial recovery from past losses](#)¹⁸, such that half-to-two-thirds of losses may be recovered over 50–100 years. Other scientists advocate for [more complex calculations that account for the impact of specific land management practices](#)¹⁹, yet these are encumbered by high uncertainty and a need for extensive data inputs. Still, others argue for [the emphasis of calculations to be on plant, not soil, processes](#)¹⁸ because plants are the primary mediator of carbon removal into soils from the air. [Estimates are also critiqued for their limited analysis on how feasible it would be to scale the specific land practices upon which they are based](#)²⁰.

Given the complexity of soil dynamics, scientists are constantly raising awareness for hitherto overlooked pieces of the sequestration puzzle, such as [the fact that most organic matter added to soils will rapidly return to the atmosphere as CO₂](#)²¹ through mineralisation by soil organisms. There is also concern that almost no estimates account for SOC saturation, which may decrease [“any potential contribution of SOC sequestration to climate change mitigation by 53%–81% towards 2100”](#)²². With estimates for agricultural soils' global annual carbon removal potential [varying by more than one order of magnitude, the extent of their role in mitigating climate change remains unclear](#)²³. Even if clarity comes, there is still concern that soil carbon practices [may sacrifice crop production](#)²⁰.

**7. To what extent can soil carbon be used as a proxy for soil health at large?**

[Scientists address the key role that SOC plays in improving soil fertility and mitigating climate change](#)²⁴, and agree that [carbon can improve soil quality across multiple dimensions](#)²⁵. However, they also highlight that soil carbon exists in many different states (dissolved, bonded to minerals, chunked as “particulates”, encased in soil particles) and [not all carbon forms are equally effective for health dimensions such as plant growth and carbon sequestration](#)²⁵. Scientists note the [close link between soil health and soil carbon](#)²⁶. Specifically, SOM, of which carbon comprises roughly 50%, is widely recognised for its decisive impact on soil quality, and more is almost always better. [NGOs](#)²⁷ and [governments](#)²⁸ agree that soil carbon measures must be included as key indicators of soil health.

Advances in MRV could help clarify these questions. As it stands, [MRV methods are beset with trade-offs between accuracy, scalability and accessibility](#). Generally, the more accurate the results, the more expensive and time-consuming the method is to scale up. Moreover, the more area is covered, the less accurate the results, requiring more corrective adjustments and cross-validation. Therefore, measuring soil carbon remains relatively inaccessible to farmers due to technicalities. Lab-based dry combustion remains the gold standard, but in-situ advancements and remote sensing technology are promising. An integrated data-driven approach can save time in the long-run but relies on breakthroughs in data collection.

Overall, the topic of soil carbon is characterised by outstanding scientific questions and technical obstacles. The answers to these questions will likely crystallise over time but, for now, their absence constrains policy options.

Political landscape summary

Momentum is growing for soil-nurturing policies in the EU. [Europe's ambition to establish soil health across its entire territory by 2050](#)²⁹ sets an example for jurisdictions worldwide. It also provides an urgent imperative to define soil health in measurable and verifiable terms.

However, [soil is entwined in political debates connected to the private economic interests of farmers, foresters, landowners, land managers, agrifood chains and “big ag” companies](#). Soil is also caught up in apparent environmental priority trade-offs when it comes to optimising for biodiversity protection, climate change mitigation and food security.

This section offers a breakdown of the policy matrix and political currents affecting EU land today, with a view to improving soil governance for posterity.

European soil governance matrix

EU soils are governed through an evolving network of policies and initiatives. Below, some key legislative measures are listed, and their combined effect and limitations are explored:

1. European Climate Law ([ECL](#))²⁹
2. Land use, land use change and forestry ([LULUCF Regulation](#))³⁰
3. Common Agricultural Policy ([CAP](#))³¹
4. National Energy and Climate Plans ([NECPs](#))³²
5. Soil Monitoring Law ([SML](#), proposed)¹
6. Nature Restoration Law ([NRL](#), proposed)²
7. Carbon Removal Certification Framework ([CRCF](#), proposed)³³

Arguably, the bedrock of European soil governance is the ECL and LULUCF Regulation that together commit to:

1. Achieving climate neutrality Europe-wide by 2050 and net negative emissions thereafter ([ECL](#)). To achieve this goal, deploying land as a carbon sink is crucial. The ECL establishes that soils play “[an essential role in the transition to climate neutrality](#)”³⁴, highlighting the prominence of agriculture, forestry and land use sectors. The key will be for Europe not to over-rely on soil and biomass to absorb emissions that should have simply been avoided. Measures are in place to cap the contribution of land-based CDR to the 2050 target, although this cap was raised last year from 225 million tonnes of carbon dioxide removal to 330 million by 2030.

2. Achieving 310 Mt CO₂e of net removals in the LULUCF sector by 2030 ([LULUCF Regulation](#)). This legally binding target requires member states to expand their land carbon sinks through managed forest land, cropland, grassland, wetlands, land use change and other activities. It also lays out rules for how to provide quality data MRV for both emissions and carbon removal.

The ECL and LULUCF Regulation provide the legal imperative for growing Europe’s [currently-shrinking land carbon sink](#)³⁵. Soil, along with vegetation, will be relied upon to meet these goals. Yet how these goals are to be met is largely relegated to other policies. Without clear direction on how best to boost Europe’s terrestrial carbon sink, the Union stands to [miss the mark by almost 100 million tonnes](#)³⁰, since additional measures planned by member states only stand to achieve a net removal of 209 Mt CO₂e by 2030.

Europe incentivises the LULUCF sector to increase its carbon removal through the CAP and, to a much lesser extent, NECPs. Together, these incentivise soil carbon sequestration through:

3. Linking direct payments to farmers with the implementation of good agricultural and environmental conditions ([CAP](#)). These payments include optional subsidies or “[eco-schemes](#)”³⁶ for member states to reward farmers implementing extra environmental care and climate action. Although not all conditions and schemes explicitly incentivise soil carbon sequestration, many supported agricultural practices would lead to a SOC build-up, especially on depleted land. Furthermore, “carbon farming” is explicitly supported, namely through conservation agriculture.

4. Incorporating soil carbon sequestration into national level CAP Strategic Plans ([CAP](#)). According to a [Carbon Gap analysis](#)³¹, twenty-one member states have included measures that explicitly target increased soil carbon sequestration, while four nations have no such commitments.

5. Incorporating soil carbon sequestration into National Energy and Climate Plans ([NECPs](#)). These plans focus on energy efficiency, renewables and greenhouse gas (GHG) emissions reductions, but some member states include activities designed to increase soil carbon storage on their territory. For example, [Croatia proposes](#)³⁷ activities such as introducing “new cultivars, varieties and crops”, “improving and changing the soil tillage system”, “[extending] crop rotation with a higher share of legumes” and “defining the potential and benefits of various agroforestry technologies”.

Due to their broad scope, CAP schemes and conditions are pertinent levers to drive holistic land health and climate action. Around 90% of the total European Utilised Agricultural Area is subject to environmental conditionalities for direct payments. Yet the CAP is notoriously weak at delivering ecological safeguards. [NGOs](#)³⁸ lament the inefficacy of the conditionality mechanism, the lack of obligations to halt and reverse degradation and the provision that gives member states ample opportunity for delayed implementation. Moreover, [aspects of the CAP continue to incentivise intensive farming driving soil carbon loss](#).

Comparatively, NECPs are a new development and their power to incentivise soil carbon sequestration as well as soil health, is yet to be seen. Most of the plans do not currently address soil carbon.

There are other EU initiatives that support SOC sequestration, such as through [Horizon Europe](#)³⁹ and [LIFE](#)⁴⁰ funding programmes. Horizon has committed €157 million to soil-related work programmes most relevant to soil carbon sequestration between 2023–2024 – an increase of €47 million based on the 2021–2022 budget. **Under Horizon, the “Soil Deal for Europe”⁴¹ aims to establish 100 soil health “living labs and lighthouses” with an objective to conserve SOC stocks.** This EU Mission emphasises the role of research and innovation, governance, collaboration and public engagement in driving change. However, these projects fall short of a systemic incentive or backstop to improve soils – a fact that is not lost on the Commission or civil society.

To this end, **the Commission has pursued two lines of action in tandem: instating regulatory bottom lines while developing a new business case for land managers.**

These approaches are not mutually exclusive; regulations penalising soil health depletion can also establish rewards for land managers who achieve exceptional land quality. Efforts to establish bottom lines and incentives are evident across the [EU Soil Strategy for 2030](#)⁴¹ (which announced the launch of the Soil Health Law), the [Farm to Fork Strategy](#)⁴² (which announced the launch of an EU carbon farming initiative), and the [Sustainable Carbon Cycles](#)⁴³ communication (which details public funding opportunities for carbon farming), among other publications.

It is unclear to what extent soil carbon stocks will be protected through legislation versus plugged into carbon markets and driven by economic forces. Based on recent developments on the SML (formerly the Soil Health Law), NRL and CRCF, the latter option is looking likely. Here is what these three proposals aim to achieve, as drafted:

- **Creating a coherent soil health monitoring system across all EU states** (SML). Gathering data based on a common definition of soil health could bridge the knowledge gap blighting Europe. It is a necessary first step to kickstart efforts to maintain and boost soil health. A comprehensive, granular soil health database could enable policy-makers to base policies on observed trends, helping Europe escalate action where and when necessary. The establishment of a digital soil health data portal goes beyond merely carbon monitoring; since [SOC concentration is a proposed Union-wide criteria for soil health](#)⁴⁴, Europe’s soil carbon sink will be mapped out like never before. Access to such data could help drive the cost-curve down for MRV methods and support civil society scrutiny of EU climate targets.

- **Introducing a voluntary soil health certification for land managers and owners** (SML). To incentivise landowners and managers to sustain healthy soils, the Commission has proposed a new certification that is [“complementary to the Union regulatory framework for carbon removals.”](#)⁴⁵ The details of how this certification will work is yet to be decided.

- **Stimulating funding for sustainable soil management across national, EU and private-sector funds** (SML). Although no new financial programmes were announced in the SML, the Commission indicated that EU support would be granted to member states to aid their monitoring schemes. The [proposal also states](#)⁴³, “it can be expected that [the SML] will stimulate the earmarking of national and EU funds for sustainable soil management, and also encourage and support private-sector funding by financial institutions, investors and related industry, such as food processing businesses.” The development of a soil health certification could help channel private sector finance to land stewards.

- **Introducing binding targets to restore degraded ecosystems, especially for areas with high carbon storage potential** (NRL). Although this law would be a gamechanger for SOC if implemented as originally proposed by the Commission, [it has been significantly watered down](#).⁴⁶ Agricultural ecosystems were removed from the European Parliament’s amended proposal, meaning that member states no longer need to demonstrate a trend of increasing SOC in cropland and mineral soils. However, soil carbon does still stand to be increased through the restoration of non-agricultural ecosystems. The main priority of this law, however, is protecting biodiversity. Any SOC gains should be perceived as co-benefits in a holistic approach to solving multiple crises at once.

- **Establishing a voluntary regulatory framework for the certification of carbon removals including “carbon farming”** (CRCF). This framework could accelerate the scale-up of sustainable soil carbon management approaches by clarifying what a certified soil-based removal comprises. This system could bestow legitimacy on soil-based carbon removal, as methodologies for certification are informed by experts, and certification bodies would conduct audits. However, unless use cases are restricted to contribution claims or only used to compensate for residual biogenic emissions, for example, negative consequences could ensue for the climate at large.

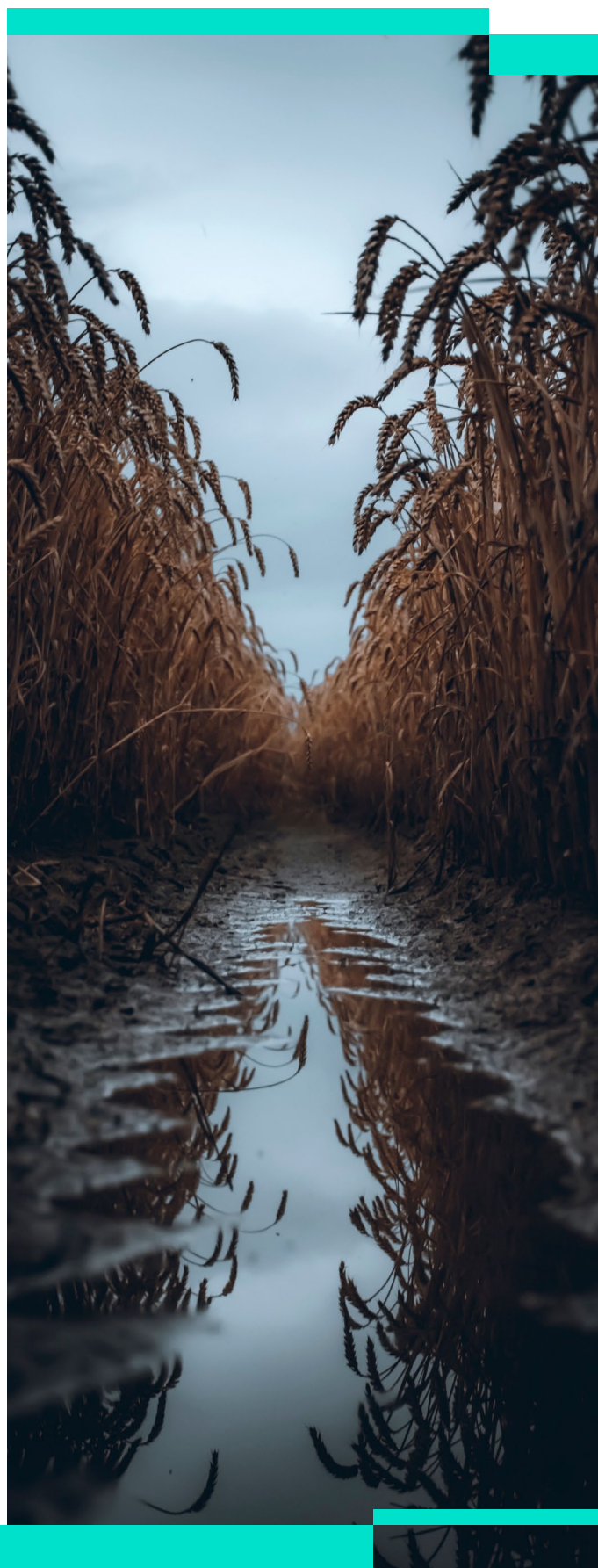
If passed, these measures could go a long way to achieving better soil outcomes, including increased SOC stocks. However, it is important to note that **the SML lacks a binding target that would legally enshrine its 2050 soil health goal.** Requiring member states to assess and report on soils does not amount to mandating sustainable management practices. It is unclear whether member states will have the authority to require that unhealthy soils be remediated or if land managers must elect to become “soil managers”. Either way, **the Commission has emphasised voluntary action rewarded through certification.** Given that soil health is not synonymous with soil carbon, the nature of the link between these certification schemes must be scrutinised.

The watering down of provisions has weakened the NRL as a lever for soil health and SOC gains. The Parliament’s proposed exclusion of agricultural ecosystems not currently under [Natura 2000](#)⁴⁷ (a network of protected sites across Europe) means that the restoration of many degraded soils will not be legally enforced. However, binding targets for other ecosystems, especially areas of high carbon sequestration potential, would help to boost Europe’s land sink.

Finally, although the CRCF could create the administrative infrastructure necessary to scale soil-based CDR in a transparent way, this framework could do more harm than good if use cases are not regulated. Creating the rules for certification is only half the battle; the other half is governing how those certificates circulate across sectors, stakeholders and countries to safeguard effective climate action.

Overall, there is significant opportunity to improve established and proposed policies related to soil.

Determining which improvements to advocate for and where best to place advocacy efforts requires further research. It is in this spirit that Carbon Gap undertook this study.



Results Summaries

Carbon Gap asked 14 soil stakeholders their views on the following topics: key issues facing European farmers today, the role of farmers in mitigating climate change, the state of EU soil data and various MRV methods, and how to implement a climate-friendly farming transition in Europe.

Interviewee expertise spanned the scientific, political and business spectrum related to soil carbon. For our sample composition (see table 1), we optimised for a diversity of viewpoints from which to identify areas of convergence and disagreement among stakeholders.

Table 1: Stakeholder Mapping: who we Interviewed

Category	Quantity	Organisation
MRV developers	5	Yard Stick PBC
		Our Sci LLC
		GENESIS - landscore
		Silicate
		Soil Watch
Civil Society	3	Carbon Market Watch
		European Environmental Bureau
		Institute for European Environmental Policy
Farmer Payment Schemes	2	Sward (dissolved)
		Soil Capital
Researchers	2	Oxford University
		Centre de coopération internationale en recherche agronomique pour le développement (CIRAD)
Farmer Representative	1	European Coordination via Campesina
Landowner Representative	1	European Landowners Organisation

In this section, result summaries are presented across all key themes, painting a panoramic picture of the state of EU soils and mapping routes to preferable futures for soil carbon governance. For each theme, a longer and more detailed presentation of the results is provided in Part 2: Digging deeper.

Issues facing European land stewards

Carbon Gap asked interviewees to identify key issues currently facing European farmers, land managers and landowners (henceforth “land stewards”). The results showed that **European farmers face challenges across environmental, economic, social, and political dimensions (see figure 1)**. Economic and political conditions drive social, land use and environmental trends, which can, in turn, set off destructive feedback loops.

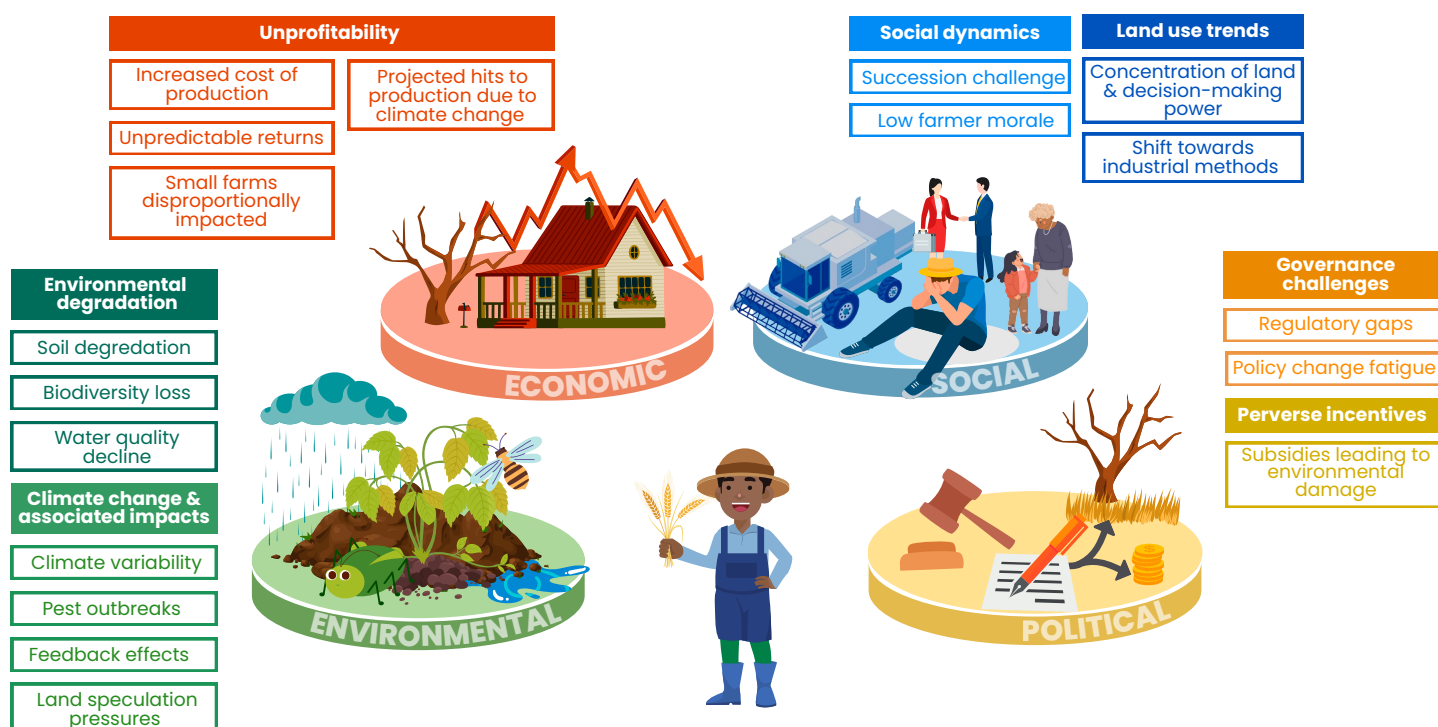
Overall, according to interviewees, **land stewards face rising environmental challenges against a backdrop of extensive pre-existing degradation**. Biological diseases, droughts, concentrated heavy rainfall, and climate change feedback effects all threaten production. To a certain extent, land stewards contribute to these issues through intensive practices and their own emissions, **creating a destructive cycle**⁴⁸. As various environmental crises continue to escalate, so too does the need for land to help solve these crises. This need generates land use competition between restoration, production and climate mitigation efforts, which often require distinct management approaches. These dynamics contribute to larger trends of farmland concentration and **land speculation pressures**⁴⁹.

Depending on the size and type of operation, **EU farmers face steep economic challenges**. The business imperative to turn a profit is becoming more difficult due to climate change and exposure to price volatility (for both production inputs and outputs), with over-reliance on public subsidies doing nothing to lighten the load. **Smaller farms are thought to be most at risk**⁵⁰.

Some interviewees noted that **European farming is undergoing a transformation in terms of who does it and how it gets done**. The “succession challenge” and land concentration trend is taking its toll on smallholder farming and “peasant” agroecology alike. Due to difficulties facing the trade, younger generations are purportedly cautious of joining. **Structural changes in farming reflect an increase in average farm sizes, with fewer and larger operations comprising the bulk of European production**⁵¹. Social pressures on farmers to manage land in particular ways are also adding to the mix, with **farmer wellbeing dropping notably low**⁵².

Politically, **weak land market regulations**⁵³ as well as **subsidies limiting farmer autonomy and harming the environment** compound challenges facing EU land stewards. Some EU policies biased towards industrial agriculture were linked to soil degradation and farmland abandonment. Moreover, recent changes to agricultural policy can leave land stewards unsure of the regulatory environment in which they operate.

Figure 1: Issues facing European land stewards



Debating the role of land stewards in EU climate action

Overall, interviewees agreed that land stewards have a significant role to play in mitigating climate change in terms of reducing GHG emissions and increasing carbon removal. Their land use decisions could be decisive for the success of Paris Agreement objectives, the EU's climate neutrality goal, net zero targets in general and counterbalancing agricultural sector emissions.

The debate on how land stewards can help mitigate climate change is fuelled by the fact that **interviewees prioritised different land functions. We therefore identified varieties of farmland priorities for Europe,** among them global food production, food sovereignty, and ecosystem health (see figure 2 for the full list). These priority orientations can be mutually exclusive, combined, or even reinforcing. Based on how these priorities are regarded, different trade-offs are perceived with varying significance bestowed per trade-off.

Beyond farmland priorities, there was disagreement over the efficacy of almost every mitigation strategy at farmers' disposal, including cover cropping, no-till, and enhanced weathering at scale (see figure 3). Interviewees also varied in opinion on the efficacy of regenerative agriculture, with some arguing it has become an unscientific catch-all term that lacks supporting evidence, while others

suggested there is enough proof to incentivise specific regenerative activities for SOC sequestration purposes.

Interviewees explored the drivers behind farmer action (or inaction) on climate change, identifying **personal attributes, physical constraints, and policy effects** as key factors. Regarding personal attributes, farmer mindset, openness to innovation, and risk tolerance levels are highlighted as playing a big role. The physical conditions of farmland such as soil type and local climate also affect whether sequestration practices can be implemented successfully. Finally, European farmers are subject to policies that perversely incentivise land-degrading practices, creating a further barrier to act within their own interest to mitigate climate change. Some interviewees noted that farmers and stakeholder groups are not solely impacted by such policies, but active participants in safeguarding them.

A multi-dimensional index can be discerned through interviewees' comments, exploring the extent to which various farms should contribute to climate change mitigation efforts (see table 2). Interviewees explored the notion that farmer responsibility for mitigating climate change should correlate, in some way, with their differential impact on the crisis. Factors such as **capability and willingness to contribute to solutions, the likely scale of positive impact, and historical exacerbation of climate change** are considered.

Figure 2: Eight varieties of European land stewardship priorities

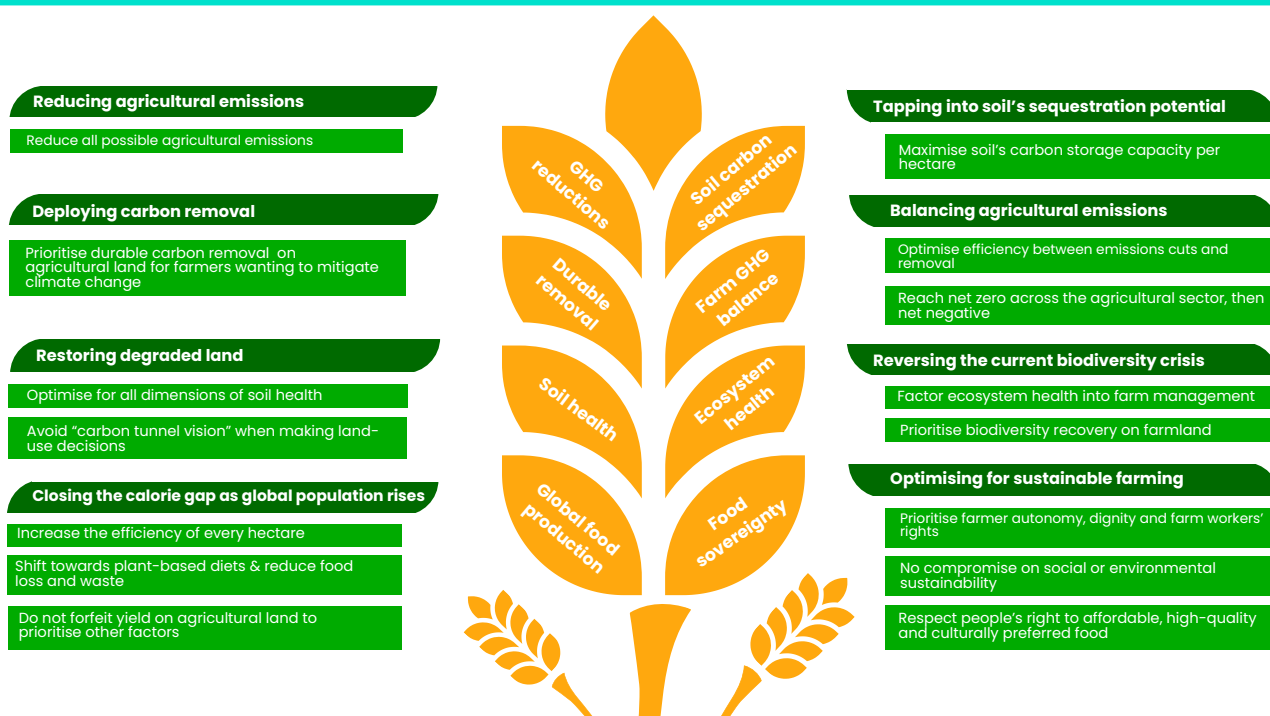


Figure 3: Interviewee perceptions of land practices for climate action

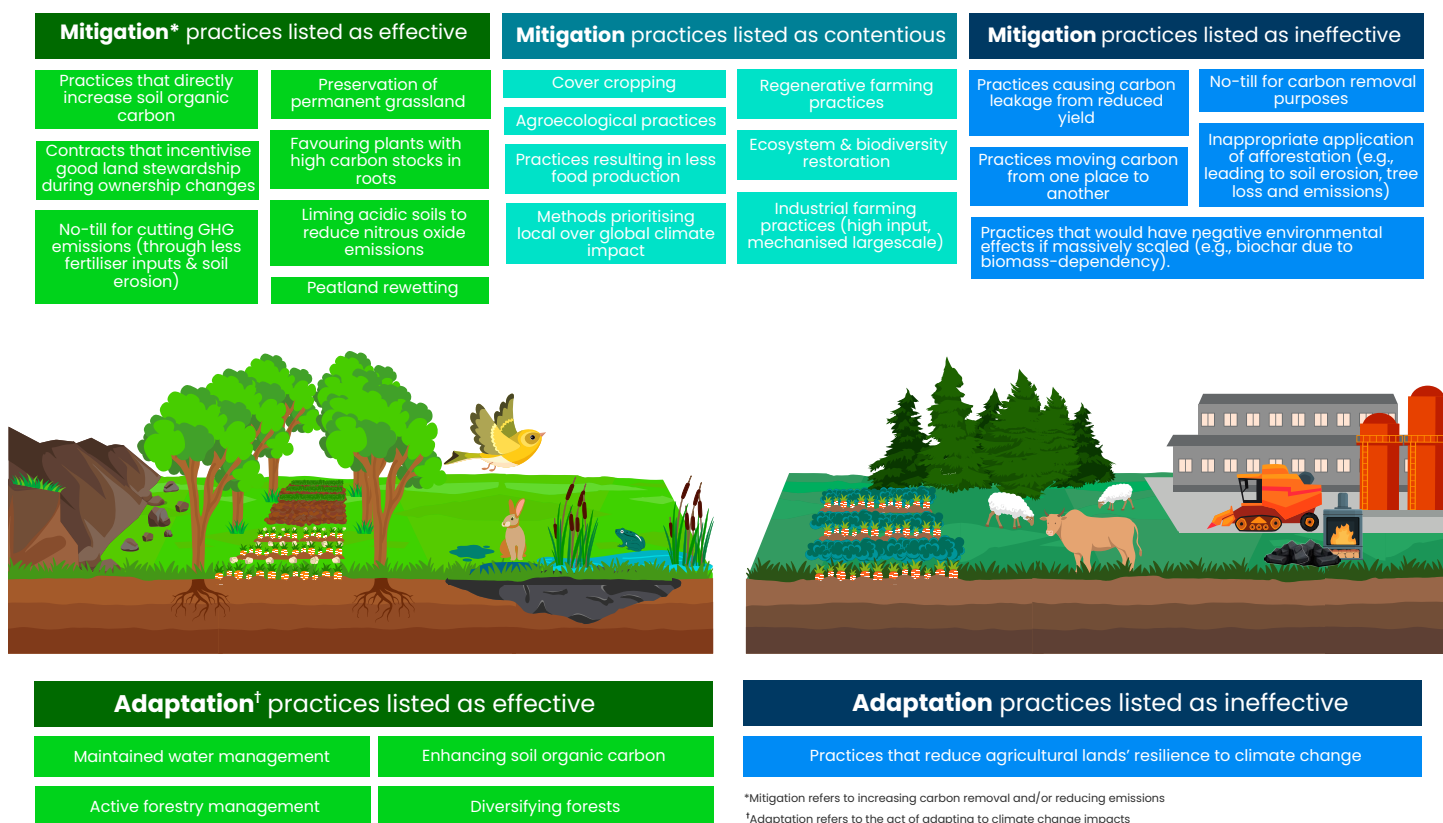


Table 2: Index of farmers' responsibility to engage with climate change mitigation

Dimension	Key Factors	High Responsibility	Low Responsibility
Capability to positively contribute	Financial Capability	High	Low
	Physical land conditions	Conductive	Inconductive
	Policy Context	Conductive	Inconductive
Willingness to positively contribute	Openness to innovation	High	Low
	Risk tolerance	High	Low
Scale of likely positive contribution	Farmland size	Large	Small
	Current carbon footprint	High	Low
Historical exacerbation of climate change	Total cumulative carbon footprint	High	Low

Soil carbon MRV: State of play and future potential in Europe

Policy decisions on how to grow soil carbon are partly based on the technological readiness of MRV methods, as well as the gaps that exist across EU soil databases. Therefore, a key aim of this research was to understand the state of EU soil data, and the potential of various soil carbon MRV methods in the works.

Europe has extensive soil data, and initiatives are already in place to build the Union's soil monitoring capacity (see box 1). Notably, the EU Soil Observatory stands to harmonise disparate national soil inventories and make soil health trend analyses publicly available.

There are many ways of measuring and monitoring soil carbon, as well as other soil indicators, including lab-based, in situ, remote sensing (RS) inputs and modelling. Lab-based MRV is costly but effective. Though not practical to scale quickly, this methodology is key to developing other MRV types, such as for novel carbon dioxide removal pathways, training empirical models, and calibrating process-based models.

In situ methods, such as spectroscopy, are a promising, cheaper alternative to lab-based MRV. There are ways to improve the efficacy of the results across soil types and by only sampling dry soil. Although interviewees argued that the uncertainty of results could be compensated for through increased sampling, concerns were raised around the transparency of the methodology. Given low trust in the integrity of carbon markets, **in situ MRV stakeholders could take an open-source or else highly transparent approach to sharing data** that would otherwise have been proprietary. Data availability could also help build toward a global training library that improves the efficacy of soil models.

Remote sensing is the most promising tool when it comes to regular monitoring of soils at global and regional scales. However, satellite imagery struggles to recover subsurface data such as soil carbon, and therefore, SOC estimates based on RS may be too uncertain depending on how RS is used. Even if RS is not used to derive SOC estimates, this technology can help identify areas that would most benefit from intervention, as well as pinpoint an optimal set of locations to sample soil.

Empirical and process-based models can be used to estimate SOC, as well as other soil phenomena. These types of models have various pros and cons (see table 3 in Part 2), but process-based models may be best at producing a more complete picture of the soil carbon in a system.

Box 1: Glossary of European soil data initiatives discussed by interviewees

EU-level

The European Soil Data Centre (ESDAC⁸⁴)

Hosted under the Joint Research Centre, ESDAC is the soil data hub in Europe. It coordinates five databases, including the European Soil Database & Soil Properties, as well as various atlases and maps, such as the [European Soil Database Maps⁸⁵](#) and the pan-European [Soil Data Maps⁸⁶](#). These maps were made user-friendly through the ESDAC Map Viewer, which integrated many layers of data (including information about soil threats), but this service was suspended in 2020. It is also the hub for soil knowledge, hosting numerous soil-specific networks and projects.

EU Soil Observatory (EUSO⁸⁷)

The EUSO was launched in 2020 under ESDAC and prompted by the European Green Deal. Its mission is to support EU policymakers to meet Union-wide soil-related objectives by providing integrated data flows and knowledge. Currently under development, the EUSO aims to fulfil this goal by implementing a harmonised soil monitoring system for the EU, improving ESDAC's capacity, and launching a novel EU Soil Dashboard that reports on soil health trends across Europe.

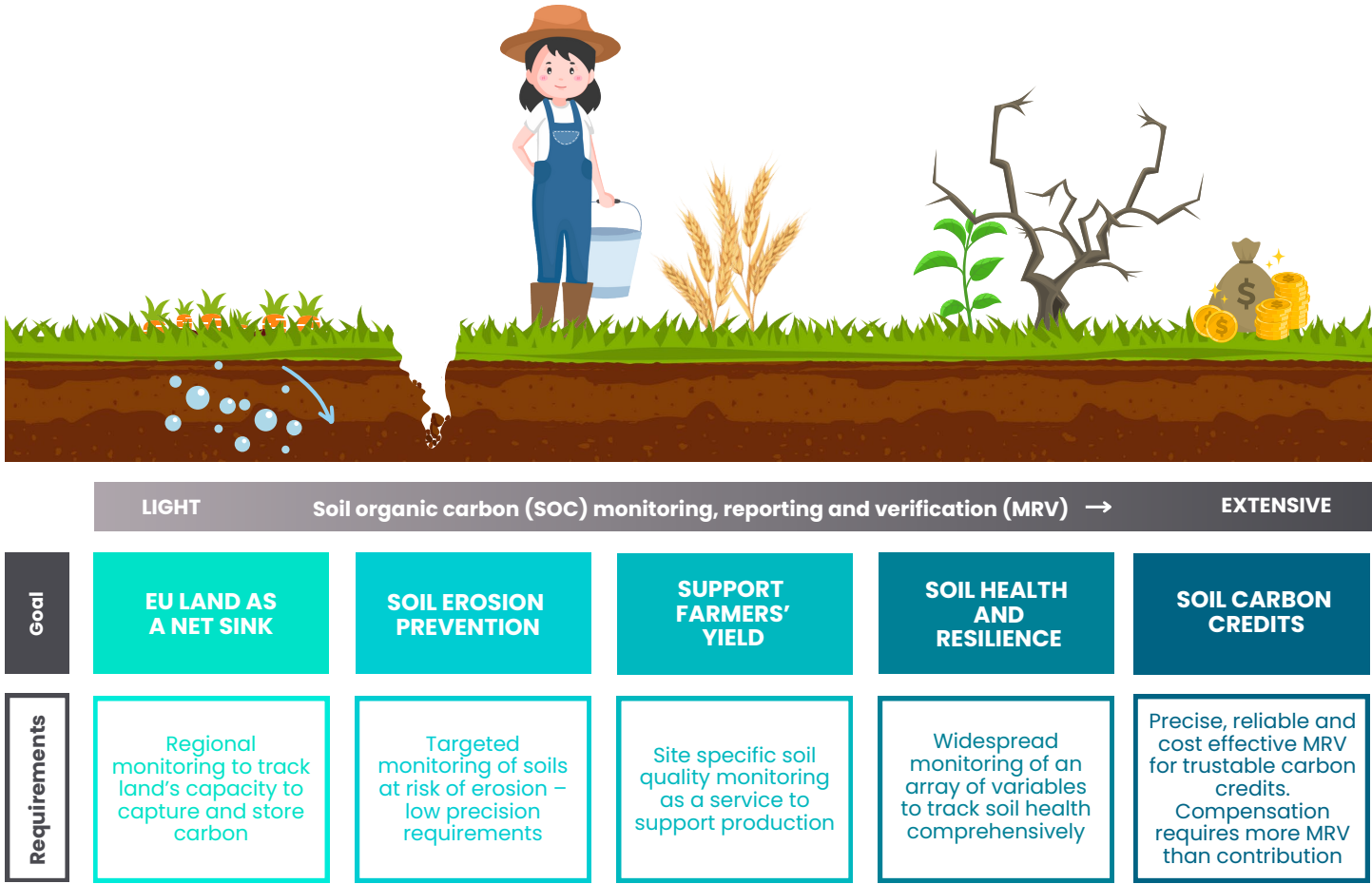
Member State-level

Basic [soil data is captured by every member state⁸⁸](#), though not all maintain a soil information system (SIS) and soil monitoring system. Nations vary in the rigour of their methodologies, resolution of results, up-to-dateness of data inputs and in criteria monitored. National level data collection is yet to be systematically harmonised into a Europe-wide database.

CAP Farmer Identification System

The CAP is also a useful repository of data as it tracks farm-level information. The EU manages payments to farmers through an integrated administration and control system (IACS), which includes systems for land parcel identification (to identify all agricultural plots in EU countries) and a [farm accountancy data network⁸⁹](#) that reports farms' income and business activities. This data is useful for any organisation that wants to track the climate impact of activities at the farm-level.

Figure 4: Measuring soil carbon depends on why it’s measured



Interviewees discussed the extent to which a robust EU-wide soil carbon MRV program is needed, noting that different use cases for the data necessitate different levels of detail and financial investment (see figure 4).

Interviewees generally considered that SOC is only interesting in so far as it relates to wider, holistic goals (such as soil health) and the cost of MRV should not overshoot its value to the public. In other words, SOC should be measured, but not for the primary goal of climate change mitigation, which could lead to “carbon tunnel vision”. The most hotly debated use case for soil data is soil carbon credits sold on carbon markets, which would require moderate to extensive MRV efforts.



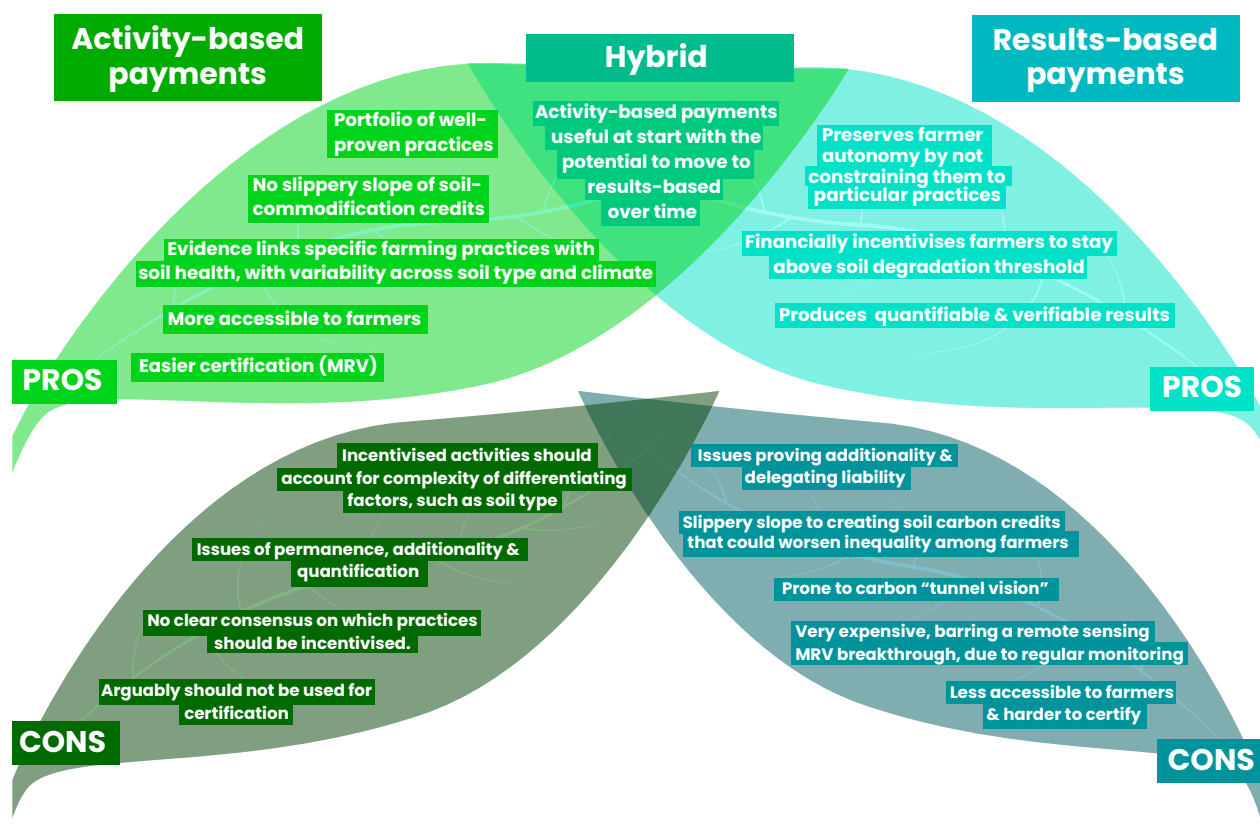
Imagining the EU's climate-friendly farming transition

Interviewees agreed that an agricultural transition was necessary but differed in their conception of what such a shift entailed. The topic was broached in terms of what to fund, who to support, who should provide support, and what is appropriate for those who pay to receive in return.

Interviewees evaluated three approaches to building soil carbon on agricultural land: **activity-based payments, results-based payments and a hybrid of the two** (see figure 5). Activity-based payments are for the application of activities, as opposed to results-based payments which are conditional on the outcomes achieved. Purely activity-based approaches are granted independent of "ends", and purely results-based schemes are granted independent of "means". **Hybrid approaches might be temporally sequential**, starting off with activity-based payments and shifting toward results-based once more data and technological advances have been made. **Or, they might be simultaneous**, with some incentives geared towards specific practices and others towards outcomes.

Interviewees differed on several major points, but the picture that emerged was one generally **against results-based payments for SOC outcomes**. Rather, incentives should drive a wider array of positive soil, social and natural impacts. In turn, the tricky issue of liability for SOC reversal to the atmosphere that is associated with results-based payments could be largely sidestepped. If soil carbon sequestration is commodified and contracted between buyers and sellers, then liability for failure to deliver or maintain sold SOC could be divvied according to logics of distributive justice, land ownership, or risk management. To ensure no single actor is lumped with the risks or costs, a shared liability model could be agreed across beneficiaries and allowed to evolve over time. However, care must be taken not to pass liability onto future generations if land changes hands. Ultimately, it may come down to **how much more buyers are willing to pay and how much less sellers are willing to sell for to create a buffer**.

Figure 5: Weighing the pros and cons of payment models for farmers



It makes sense that **those who do the work should be rewarded for that work**, which means farmers, foresters and land managers should be the recipients of support. Incentives should not be concentrated in the wrong hands – for example, landowners letting to farmer tenants or to too many middlemen. Beneficiaries of support could be prioritised based on need and operation size.

Public funding (and regulation) is the primary lever to catalyse this transition, due to soil's character as a public good and preestablished government mechanisms that could be speedily deployed (see table 3 for a full list of all proposed "payers"). **However, finance from the private sector should be mobilised**, especially as it pertains to internalising the environmental cost of agricultural production and reducing scope 3 emissions along supply chains with nature-sourced products. If farmer payments are made on the basis of SOC gains, these cannot be expected to fix farm finances or catalyse major change in EU agriculture. Rather, they would serve as a cherry on top of the annual balance sheet.

However, if the private sector is mobilised, then **safeguards must be put in place against greenwashing**. In general, interviewees thought that any claims made off the back of soil carbon or soil health should be **limited to contribution claims and not compensation or net zero claims**.

Interviewees also warned against commodified soil carbon offsets due to the unpredictability of soil carbon, high risk of reversal back into the atmosphere and extensive MRV challenges.

Zooming into the agricultural sector, a more detailed logic emerges. For example, some stakeholders may qualify for a polluter pays approach, whereby they are incentivised to reduce their carbon footprint through the prospect of incurring a penalty. **More broadly, interviewees felt that not all farms should be privy to incentives** for ethical and economic reasons, and perhaps it is inappropriate to incentivise something that is already within farmers' best business interests to do.

Table 3: Climate-friendly farming: who should pay and how

Actor	Mechanism
 GOVERNMENT	 CAP 40% of the Common Agricultural Policy's €-155 billion budget is expected to go towards climate spending between 2023–2027. Member states have autonomy over how to spend their budget and meet their climate goals.
	 SML The Soil Monitoring Law could set legal requirements to stay above "soil health thresholds" creating financial stakes if member states fall short of Union-wide target
	 NRL The Nature Restoration Law could be used to set legal requirements to restore degraded soil ecosystems, creating financial consequences for those member states that fall short
 PRIVATE SECTOR	 CRCF The Carbon Removal Certification Framework could set the standards necessary to bring in private finance, but associated use of certificates must be heavily regulated.
	 Voluntary Carbon Markets Voluntary carbon markets could boost funding for soil carbon removal, but claims must be heavily regulated and double counting must be avoided
	 MRV Providers Direct payments to MRV providers as middlemen between the private sector and farmers could help companies expediently receive information on soils.
 AGRICULTURAL SECTOR	 Farmers Direct payments to farmers could empower the private sector to reduce scope 3 emissions and, depending on MRV and regulatory constraints, provide supporting evidence for soil carbon claims.
	 Products Internalise the cost of environmental impact of farm products into their price. Doing so would disincentivise environmental depletion across the supply chain as all players would want to reduce costs. It would also allow farmers to become less dependent on public subsidies.
	 Ag-ETS An EU agriculture-specific Emissions Trading Scheme could drive polluters to counterbalance residual biogenic emissions with certified soil carbon removals

Soil transition in practice: Interviewees' policy propositions

Beyond characterising challenges, Carbon Gap invited interviewees to propose policy ideas to bridge the gap between the present and their envisioned future. Collectively, interviewees listed the following principles and concrete propositions (detailed in Part 2: Digging deeper).

The first set of propositions called for soil governance to balance priorities across contexts and scales.

Interviewees concerned about the "carbon tunnel vision" highlighted the need to approach soil through **a multi-dimensional lens**, whereby its primary role of regulating water and air quality, ensuring food production, and supporting biodiversity are viewed as the main benefits of soil governance, and positive climate outcomes are co-benefits. Accordingly, they proposed that the Soil Monitoring Law, Nature Restoration Law, and the LULUCF Regulation should be the centrepieces of soil governance, as opposed to climate legislation.

Interviewees also suggested that to achieve **better climate outcomes at the global level**, EU imports and exports should be redressed. In the first instance, imports of environmentally harmful products should be reduced. The **EU's land productivity should be preserved or increased** to avoid exporting negative soil impacts beyond its borders, and to meet new demand from countries that might otherwise be met by less climate-friendly producers.

A second set of propositions called for the EU to implement measures that reduce pressure on soils.

These propositions include using soils more efficiently, shifting dietary preferences towards plants over meat and reducing demand for soil-based products by cutting food loss and waste.

Regarding climate change mitigation, interviewees suggested **the EU prioritise solutions that have a lower land-footprint; cases where two solutions have the same climate impact, the solution with a lower land-footprint** should be favoured. Interviewees further suggested that policy-makers restrict the role of soil carbon storage in meeting the Union's climate neutrality goal, given high scientific uncertainty and the relative importance of carbon compared to other soil services.

Another wave of propositions entailed reforming the EU soil governance matrix for better soil outcomes.

These propositions mainly related to changing the CAP so as not to bias against small farms, setting fair prices for agricultural products, and spending the CAP budget in a more democratic way.

Interviewees also explored ways of upping Europe's chances of success on soil goals by setting legally binding targets for soil health. These targets would require an associated mandatory MRV effort. Other interviewees discussed a polluter pays scheme that could pressurise Big Ag companies to reduce their carbon footprint.

A range of incentive types were proposed to support land steward efforts. Interviewees explored what exactly should be paid for, with some suggesting direct payments to farmers for passing ecosystem health thresholds, and others proposing that emissions avoidance, emissions reductions and carbon removal be remunerated.

Activity-based incentives were widely supported, alongside different degrees of hybridisation with results-based incentives.

Finetuning the supported practices according to local conditions was a point of agreement, while the efficacy of some practices remains contentious. Finally, some interviewees argue that soil governance must be designed in a way that alleviates (or at least does not exacerbate) inequalities blighting the EU's farming sector. Doing so entails addressing the various levels of responsibility for worsening climate change among farmers.

Some interviewees strongly opposed market-based approaches (whereby soil carbon is "commoditised" and traded) on the grounds that the risk of reversal of carbon into the atmosphere is too great, and the EU is equipped with better options. On the CRCF, **some interviewees suggested prohibiting the use of certified soil carbon units for compensation claims**. Contrastingly, other interviewees supported the trading of soil carbon certificates and associated remuneration and called on the EU to de-risk carbon markets for farmers and the private sector alike.

The last wave of propositions addressed MRV.

Interviewees generally agreed that, depending on EU soil objectives, an appropriate level of granularity for MRV should be identified and not exceeded. Up until a certain point, soil MRV can be seen as a public good deserving of public spending. On the other hand, MRV can become an expensive investment used to ready soil carbon markets for business. Interviewees generally agreed that public spending on soil MRV should be limited to match the public benefit derived. Accordingly, the EU should be willing to fund the collection of reliable baseline data across EU soils and at regular intervals thereafter, but any further granularity should be funded by the private sector.

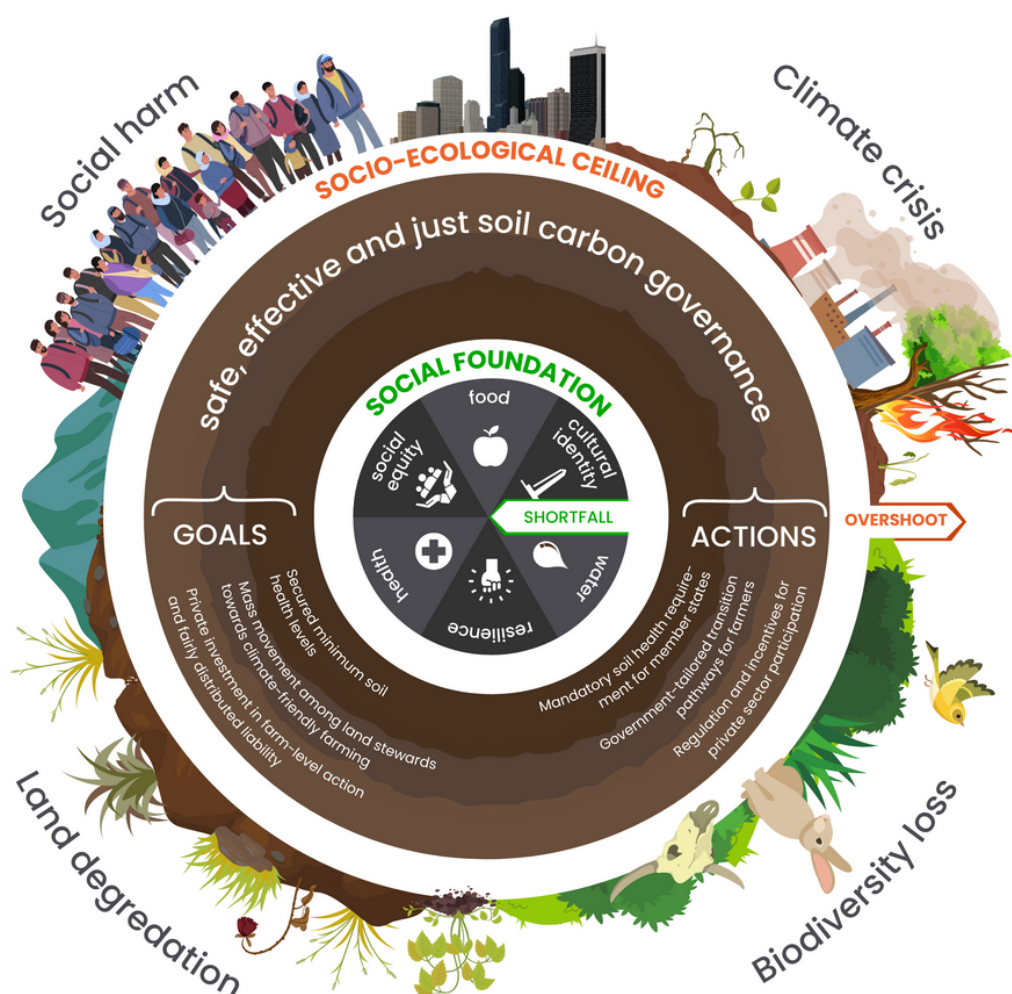
Carbon Gap's Take

This research illuminates the complexities at play when designing soil carbon governance. A general lack of scientific consensus on how soil carbon sequestration occurs, and which activities best instigate and preserve it means that policy-makers must make decisions under sub-optimal conditions. Similarly, the polycrisis of biodiversity loss, climate change, industrialisation and concentration of farmland, and soil degradation means that land management decisions bear many implications and depend on larger trends beyond stewards' control. This interconnectedness is a given and is unlikely to change.

Therefore, one major conclusion of this study is that **EU soil carbon governance must account for this complexity.**

Luckily, increasing Europe's soil carbon sink need not sacrifice other priorities. Below, **Carbon Gap offers a conceptual framework to help policy-makers keep relevant trade-offs and implications in mind.** We further suggest a multi-layered approach that leverages the power of regulatory bottom lines, public sector incentives, and private sector involvement to achieve sustainable management of EU soils and their carbon.

FIGURE 6: Representation of the “doughnut” approach for soil carbon governance in the EU



The central ring represents the “safe space” in which EU soil carbon governance should ideally operate. This space is confined by a social foundation of life-supporting soil services and a socio-ecological ceiling which must not be exceeded. Within this space, policy-makers enjoy many

options. Carbon Gap advocates for a three-pronged approach mixing mandatory requirements, tailored transition pathways for farmers and private sector stimulus to avoid a shortfall in any essential soil functions or driving unsustainable trends.

Framing the challenge of soil carbon governance to policy-makers

To maximise the benefits and avoid undesirable trade-offs of EU action on soil carbon, Carbon Gap suggests **adopting the “doughnut” approach⁶¹ innovated by economist Kate Raworth.** The doughnut we have designed (see figure 6) defines the space for “safe, effective, and just soil carbon governance” as confined between two boundaries. The first boundary is a social foundation of essential services related to soil that governance must uphold. For example, policies should be in place to ensure there is enough carbon in soils to maintain food production while also ensuring social equity is not jeopardised in the process. The second boundary is a socio-ecological ceiling which soil governance must not overshoot. It would be a governance failure if soil carbon measures led to a deficiency in any of the six social foundation dimensions or contributed to the four unsustainable trends above the socio-ecological ceiling. Given that this ceiling has largely been overshoot **at the global level⁶¹**, it is also incumbent on governance to reverse such trends.

The goal of governance is to shepherd land stewards to operate within this safe, effective, and just space. When it comes to soil carbon, therefore, increases should be mandated where SOC deficiency threatens the social foundation, and otherwise welcomed so long as increases do not blight social, biodiversity, climate or food production outcomes.

Optimising for any single soil function risks perverse outcomes, and SOC is no different. In the past, it was yield. Now, with the commodification of SOC on voluntary carbon markets (VCMs), and the prospect for EU certified soil carbon removal, there may be a scurry to capitalise on this new revenue source. **Carbon Gap shares the concerns expressed by several interviewees about “carbon tunnel vision”** and hopes that a multi-dimensional “doughnut approach” can help constrain this prospect.

It is important to note that while figure 6 deals with EU policy-making, the foundation and ceiling refer to the global scale. EU soil management has a global impact and governance decisions must be made with this context in mind. Accordingly, the EU should support a shift toward plant-based agriculture and diets, reduce food loss and waste, and redress its imports/exports.

A three-tiered approach to soil carbon governance

As mentioned above, there are many options at policy-makers’ disposal to establish a safe space for soil management. Based on our findings, **Carbon Gap advocates for regulatory bottom lines, incentives for voluntary action, and private sector efforts to work in concert for optimal effect.** The layers should be compatible (stackable) to create a gradual incentive to do more for soil health restoration and soil carbon while leaving optional the most ambitious and demanding options.

Tier 1: Secured minimum soil health levels

Mandatory requirements are the foundational layer of our suggested approach. Soils must stop degrading and losing carbon. This aim could be enforced by strengthening the CAP’s good agricultural and environmental condition (GAEC) of land standards, with results-based targets supported through MRV. This floor condition could change over time to correspond with EU objectives, avoiding permanent payments once the transition has been achieved.

In the same vein, the EU’s 2050 soil health target should not remain aspirational. Introducing a **legally binding soil health target** would commit member states to undertaking a true transition, and not over-relying on farmers voluntarily electing to become exemplary soil stewards.

It follows that data collection must be harmonised Union-wide so that progress can be monitored and targets enforced; you can’t manage what you don’t measure. A widespread increase in soil health monitoring efforts appears to be a no-regret investment, as it would bring multiple benefits including ground truth data, which remains a bottleneck for unlocking indirect soil carbon MRV methods.

A legally binding target and robust methodology to monitor progress is needed to secure minimum soil health levels across the EU. However, progress cannot be made without enlisting land stewards to enact change en masse. This change entails removing perverse incentives as well as creating new supportive mechanisms. Farmers differ in risk profile, business model, financial capacity, levels of responsibility for climate change and many other dimensions. Successful policies will embrace and leverage this diversity by providing **tailored transition pathways** where simplistic blanket approaches are poised to fail.

Tier 2: Mass movement among land stewards

The second layer of our approach explores how to involve the majority of land stewards in a positive transition. This goal requires safeguarding farmer autonomy and freedoms, as well as acknowledging the **different levels of responsibility and capacity to make significant changes among land stewards**. Beyond soil health thresholds, farmers can be incentivised to increase soil carbon stocks through results-based, activity-based or hybrid schemes.

Our research highlights contrasting views on the efficacy of such approaches. **On balance, we suggest a hybrid approach that gets the best of both worlds**. In exchange for funds, farmers could voluntarily sign contracts with the EU to practice the specific activities thought to increase carbon on their land. Funding must be attractive enough to persuade many farmers to partake. The efficacy of these practices could be monitored through MRV checkpoints; expected results could be compared with ground truth data to improve predictive models. A combination of direct and indirect MRV methods could be used for checkpoints to monitor progress across all soil health indicators. Member states could tailor practices and associated funding to reflect local specificities but should be mandated to provide a list of activities that qualify for funds. This initiative, which could be folded into the CAP's agri-environment and climate measures (AECMs), would allow the EU more control over meeting its soil health goals than relying on voluntary carbon markets, which are accompanied by price volatility and public distrust.

Tier 3: Private investment and fairly distributed burdens

The third layer of our approach involves the private sector in Europe's soil restoration effort. This goal might entail new regulations requiring companies to reduce their scope 3 emissions, spreading out the burden of change across nature-sourced supply chains. Alternatively, or in tandem, private sector involvement could be based on the certification of soil carbon units (typically under the CRCF framework) representing net tonnes of CO₂ removed. Private actors could buy these certificates to meet their climate objectives. Contribution claims may be allowed if sufficiently regulated to avoid the "smokescreen" effect whereby small contributions are used to hide emissions reductions failures.

Compensation claims would need to be restricted to residual biogenic emissions, in accordance with the like-for-like principle. MRV steps could differ depending on the nature of the claim, with all contribution claims requiring results-based MRV. The extra MRV required to create reliable units would be rewarded by a premium. However, ensuring that soil carbon units are only used to counterbalance biogenic emissions will be tricky in practice, as will managing liability for the stored carbon. Furthermore, the certification step should pay particular attention to non-carbon objectives and comprehensively evaluate the land management changes made to achieve the storage of carbon.

Recent conversations on soil MRV have focused on the most demanding scenario: the certification of tradable carbon units. The challenge evidenced by this research is that soil carbon science is not settled. Combining precision and scale for soil carbon measurements remains a challenge. Scalable MRV techniques such as in situ spectroscopy are promising but still need to absorb more ground truth data to prove their quality. Simultaneously, SOC is exposed to numerous factors beyond land stewards' control, notably climate variability and climate change. These realities mean that **we are not yet fully equipped to interpret the extent to which a positive or negative evolution of the SOC is due to land stewards' actions or to natural phenomena**. This fact is particularly problematic where the maximum level of certainty is needed (for example, when SOC is commodified and used for compensation claims).

Payments engender liability for the climate outcome that was traded (e.g. the stored carbon). The burden of this liability could be shared across those who benefit from the transaction, but care must be taken not to pass on liability to those who do not benefit. As it stands, the lack of maturity of scalable MRV options and the uncertainty associated with the interpretation of site-specific SOC trends present a serious problem in the case of unexpected variations. These issues also restrict the use of insurance schemes that could cover such situations.

By opting for a hybrid approach and largely limiting the soil carbon market to contribution claims, the stakes on soil MRV can be alleviated. For the certification of tradable carbon units, combining the different MRV tools can mitigate their individual shortcomings. While more MRV comes at an increased cost, it is probably necessary until scalable and precise MRV is unlocked by additional ground truth data.



Ensuring safe, effective and just soil carbon governance

In conclusion, the EU should not over-rely on soil carbon to meet its climate objectives due to the vulnerability of soil carbon stocks to climate change and the potentially slow speed of an agricultural transition. Concretely, EU policy-makers should base their decisions on conservative estimates on soil's carbon removal capacity and durability.

Yet restoring soil health across EU land is strategic. It can increase Europe's resilience to climate change and maintain soils' capacity to provide multiple resources and services. Increasing SOC contributes to this aim.

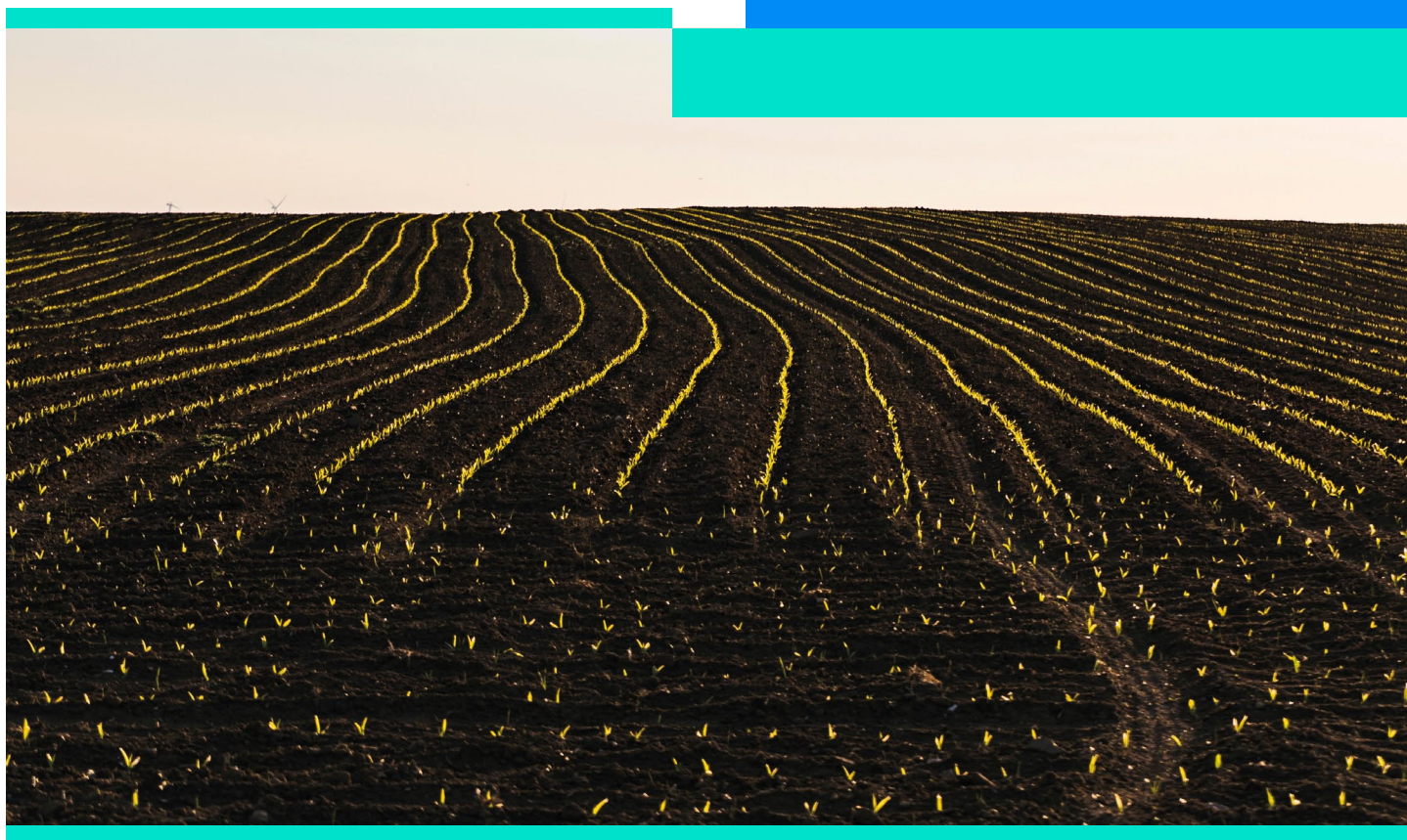
The EU must have control over its trajectory towards meeting its 2050 soil health target, which is why voluntary approaches are insufficient. The holistic "doughnut" lens proposed in figure 6, together with our three-tiered governance matrix, can help the EU account for the diversity of challenges facing soil, and to identify and shut down policies providing perverse incentives that work against the desired transition.

While the certification and trade of soil carbon units presents an opportunity to involve the private sector and a potential new source of income for land stewards, Carbon Gap is concerned that it could make land stewards liable for highly labile carbon stocks, especially given that there are no clear and fair mechanisms to address unexpected variations in SOC. Compensation and contribution efforts based on such units must also be strongly regulated to avoid greenwashing and mitigation deterrence.

Finally, EU soil carbon governance must be crafted in light of the bigger picture. It should link soil health policies to food governance to ensure both are going in the same direction, as well as balance the many priorities humans have for land at the global scale. Diversifying CDR approaches, particularly those techniques that have a small land-footprint, could alleviate the pressure on soil carbon, leaving more space for soil health.

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About Us

Carbon Gap

Carbon Gap is an independent, philanthropically funded, non-profit organisation focused on responsibly scaling up carbon dioxide removal in Europe, as an important complement to emissions reductions. We work across all carbon removal methods, bringing the best technical expertise to inform European policymaking. Our advocacy efforts are focused in Brussels, with additional staff presence in France and the UK.

www.carbongap.org

The logo for Carbon Gap, featuring the word "Carbon" in white on a dark grey background and "Gap" in white on a blue background.

Carbon Gap

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