8

REMOVALS AND EMISSIONS FROM AGRICULTURE AND FORESTRY

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Introduction

Agriculture and forestry not only contribute to emissions but also have the potential to capture and store carbon dioxide from the atmosphere. The range of "climate smart" measures available to agriculture and forestry[2] surpasses that of many other sectors, highlighting their unique role in addressing climate challenges.

Since 2012, agricultural emissions from livestock management and use of fertilisers have been included in the Effort Sharing Regulation (ESR), while emissions from land use, land use change and forestry (LULUCF) promoting net carbon sequestration from agricultural land and forestry within its borders are covered under the LULUCF Regulation.

The Paris Agreement, adopted in December 2015, emphasised the need to achieve "a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of the century." Moreover, it calls upon Parties to conserve and enhance the capacity of greenhouse gas sinks, including those in forests.

In 2021, the European Union significantly increased its initial Paris pledge and now aims to reduce its greenhouse gas emissions by at least 55% by 2030 compared to 1990, including a maximum of 225 million tonnes of net removals. For the EU to move to climate neutrality by 2050, emissions from agriculture, forestry and land use will have to become net zero by around 2035.

As a consequence, in 2023, the EU further strengthened its legislation by setting for the first time a separate 2030 target of 310 Mt of net removals from land use, land use change and forestry (LULUCF). This EU-wide target is then allocated to individual Member States. This requires active involvement of the agriculture and forestry sectors, which have the unique ability to

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both contribute to emissions reductions and remove carbon dioxide from the atmosphere. This dual role holds global significance, as these sectors account for approximately 20–25% of global emissions, largely driven by tropical deforestation.

This chapter provides an understanding of the evolution of policies for these sectors, their key features, and the recent updates. It also addresses the current status of existing initiatives, discusses strategies to overcome sector challenges and examines the enabling environment for climate action in forestry and agriculture.

8.1 The Role of the Land Use Sector in Mitigating and Removing Greenhouse Gas Emissions

The land use sector encompasses the management of various land categories such as cropland, grassland, wetlands, forests and settlements. Additionally, it includes land use change activities such as afforestation, deforestation, the draining of peatlands and the utilisation of harvested wood products. Covering more than three-quarters of the EU's territory, the agricultural and land sector offers ample opportunities to reduce agricultural emissions and to remove carbon dioxide (CO_2) from the atmosphere.[3]

The greenhouse gas cycles associated with agriculture and forestry are complex, encompassing both non-CO_2 and CO_2 emissions, as illustrated in Figure 8.1. In agriculture, non-CO_2 greenhouse gases, primarily nitrous oxide (N_2O) from nitrogen fertilisers and methane (CH_4) from livestock digestion, contribute to more than half of the EU's non-CO_2 emissions. These emissions accounted for 10.9% of the total emissions in 2021, while net LULUCF removals made up 6.6% showing that overall the agriculture, forestry and land use sector remained a net emitter.[4]

Most of the nature-based avenues for the removal of CO_2 are reversible. When trees are cut down or grassland is converted to arable land or regenerative soil management practices are reverted, the carbon stored in them is released back into the atmosphere. Still, implementing effective carbon removal strategies in the EU becomes essential to counterbalance residual emissions and, beyond climate neutrality in 2050, to generate the required net negative emissions. To evaluate the role of land use and forestry in climate protection, it is crucial to annually monitor the balance between emissions and removals from agriculture and forestry. Increasing CO_2 storage in trees and reducing CO_2 emissions from agricultural land through improved soil protection will enhance their contribution to climate protection. Additionally, well-managed agriculture and forestry can provide sustainable and domestic raw materials for industry, energy and transport sectors transitioning away from fossil fuel dependency.

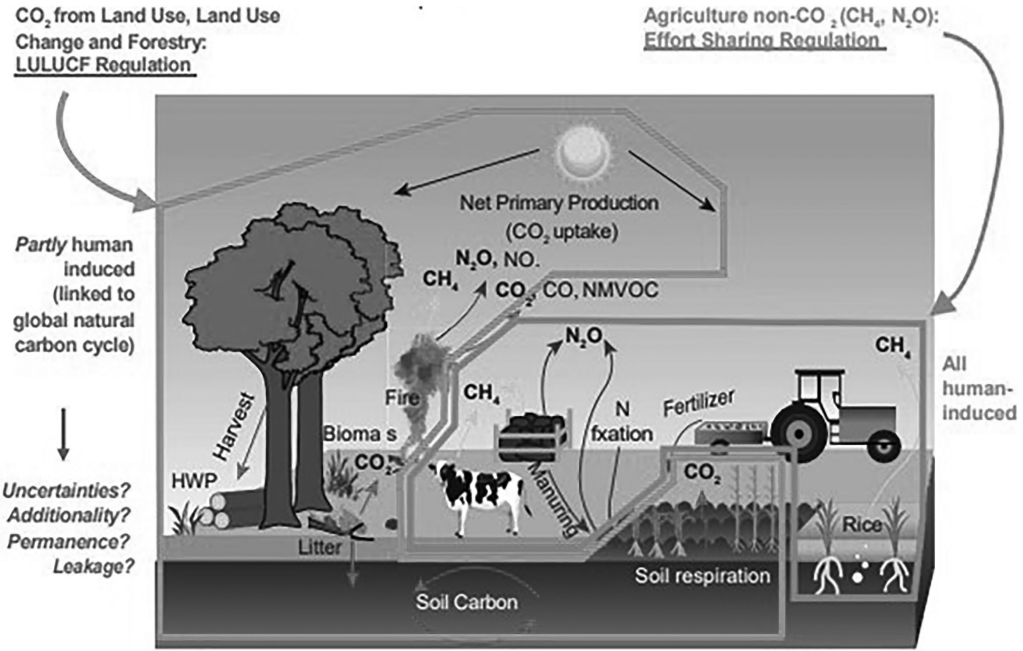

FIGURE 8.1 Land use and agriculture in EU climate policies

Source: IPCC (2006)[5]

One notable advantage of climate action in forestry and agriculture is their positive impact on agricultural productivity, climate adaptation and biodiversity conservation, particularly in a long-term perspective. Increasing soil organic matter in intensively farmed soils protects productivity, reduces erosion and fosters beneficial microorganisms while promoting sustainable agriculture and biodiversity conservation.[6] Sustainable land management is crucial for climate resilience as healthy ecosystems provide vital services such as flood protection, desertification prevention, air pollution reduction and urban heat mitigation. Recognising the interconnectedness of carbon sinks, biodiversity and climate change adaptation, the EU emphasises the significance of sustainable land management in reversing biodiversity loss and addressing climate change impacts effectively.

Conclusion: Emissions reductions and carbon removals in agriculture and forestry are vital for achieving the EU's climate goals. Significant additional efforts are needed to properly manage complex greenhouse gas cycles, monitor emissions and promote sustainable land management.

8.2 The LULUCF Carbon Sink in the EU

The LULUCF sector, as shown in Figure 8.2, in the EU acts as a net carbon sink, absorbing CO_2 through afforestation and forest management, but emitting CO_2 due to deforestation, cropland management, draining of peatlands and land-use changes. The sector's performance fluctuates from year to year mainly due to natural disturbances like storms, wild fires and droughts

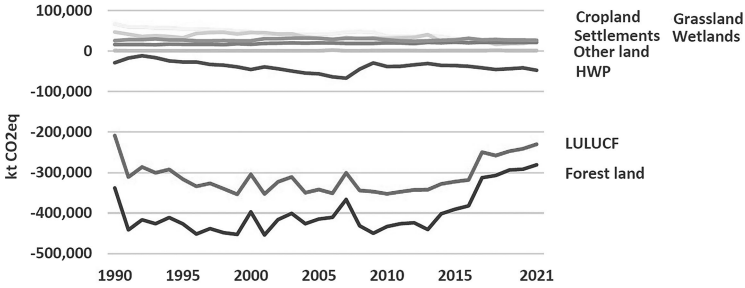

FIGURE 8.2 LULUCF emissions and removals by source and emissions

Source: European Union (2023)[7]

and also changes over time due to management changes as a result of, for example, increasing adverse effects of climate change, the age structure of forests, or market signals induced by renewable energy and biofuels policies. Important challenges remain for the sector in view of the ambitious 2030 target. Firstly, forest ecosystems' carbon sinks have been steadily deteriorating since 2000. Secondly, non-forest land uses continue to show overall net emissions. Particularly, the reduction of the significant emissions from the use of drained peatlands for arable crops or grasslands remains challenging for several northern European Member States including Germany, Poland, Ireland, the Netherlands, Finland and Sweden.[8]

Since 2012, the EU has implemented specific legislation to address land and agricultural emissions focusing on sustainable land use practices. Two significant developments are the Effort Sharing Regulation (ESR) and the Regulation on Land Use, Land-Use Change and Forestry (LULUCF). As illustrated in Figure 8.1, these policies are designed to address specific aspects of emissions reduction and land use management within the EU.

The ESR[9] (see Chapter 6) sets individual binding emission reduction targets for Member States, including non-CO_2 emissions from agriculture, while the LULUCF Regulation focuses on land and forest management, recognising their potential for carbon dioxide removals through sustainable land use practices. The ESR Regulation aims to achieve a collective reduction of 40% by 2030, relative to the emissions recorded in 2005. The LULUCF Regulation sets a net carbon dioxide removal target of 310 Mt CO_2eq by 2030.

8.2.1 Evolution of LULUCF: From Kyoto Protocol to Ambitious EU Targets

The EU's policy related to land use started with the implementation of the Kyoto Protocol, which sets out that LULUCF activities had to be included in the accounting framework for greenhouse gas emissions and removals. Participating nations were required to set binding national targets for reducing their greenhouse gas emissions, including emissions and removals from the land use sector.

In 2012, the EU took a significant step towards implementing the Kyoto Protocol by developing accounting methodologies and systems to track emissions and removals from LULUCF activities within its Member States. This process required establishing transparent and consistent procedures for monitoring, reporting, and verifying emissions and removals associated with land use, land use change and forestry.

However, during the period from 2013 to 2020, the LULUCF sector was not included in the EU's domestic climate commitment. Nonetheless, EU Member States recognised the importance of monitoring agricultural

land and improving management practices on croplands and grazing lands. The Decision No 529/2013/EU[10] on LULUCF accounting rules generated valuable information, identifying emission hotspots and promising mitigation actions across the Member States, laying the groundwork for future inclusion of the LULUCF sector in climate action initiatives.

Following the ratification of the Paris Agreement, the EU adopted a 2030 target of reducing emissions by 40% compared to 1990, including the LULUCF sector for the first time, recognising the importance of addressing emissions and enhancing sinks to achieve its climate goals. Subsequently, the LULUCF Regulation (EU) 2018/241[11] was created.

With the enactment of the 2021 European Climate Law, a binding target was set of at least 55% net emission reduction by 2030 compared to 1990 levels, necessitating the upgrade of the LULUCF Regulation. As a result, the revised EU LULUCF Regulation establishes a new target of removing 310 million tonnes of CO_2eq by 2030 at EU level and sets individual net removal targets for Member States from 2026 onwards as shown in Figure 8.3. For each Member State, this represents an increase of approximately 15% in removals compared to the reference period from 2016 to 2018.

8.2.2 Building Further on the 2018 LULUCF Regulation

The 2018 LULUCF Regulation introduced accounting rules and provisions for the monitoring and reporting of greenhouse gas emissions and removals in the land use and forestry sector. It includes specific guidelines for different land use categories, such as cropland, grassland, deforested and afforested land, managed forestland and harvested wood products. Member States must adhere to best practice principles such as accurate, complete, consistent, comparable and transparent accounting. It positions LULUCF as a stand-alone pillar alongside the EU ETS (Emissions Trading System) and the Effort Sharing Regulation, emphasising its significance in achieving climate goals. It incentivises the conservation, restoration, and expansion of forest and soil carbon sinks to work towards carbon neutrality in line with the goals of the Paris Agreement.

The revised Regulation[12] introduces key changes to address inconsistencies, ensuring more accurate accounting of emissions and removals and improved transparency in reporting. For the first time, net carbon removals targets are set for each Member State. Equally important, with the end of the last commitment period under the Kyoto Protocol, the Regulation moves away from the previous Kyoto accounting rules, no longer requiring double reporting and making accounting now fully consistent with the UNFCCC reporting rules.

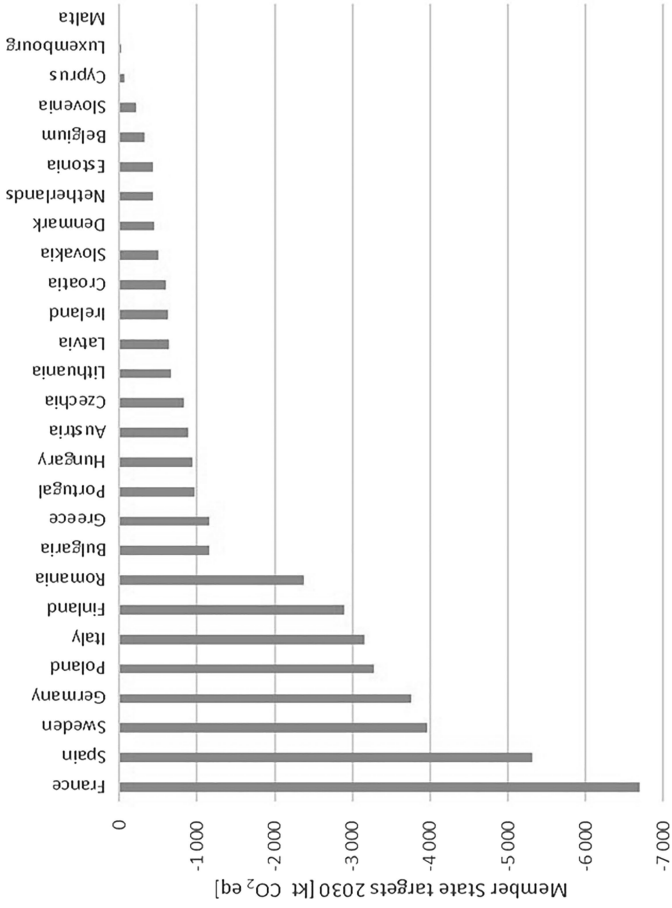

FIGURE 8.3 Net removal targets for EU Member States

Source: EU Regulation (2018)[13]

The revised Regulation consists of two phases:

- Phase 1 from 2021 to 2025: Remains close to the 2018 LULUCF Regulation, including the "no debit" rule and the accounting rules for the different land use categories.
- Phase 2 from 2026 to 2030: This phase enlarges the territorial scope to cover all managed land, simplifies compliance rules, and enhances data monitoring using advanced technologies like remote sensing and Earth observation.

The revised Regulation improves governance and enhances the quality of monitoring, reporting, and verification of emissions and removals through to new land monitoring technologies, techniques, and datasets generated by the EU's Common Agriculture Policy[14] (CAP). Better information will help Member States adopt more effective policies and measures, and land managers take up new carbon farming schemes (ways of farming that sequestrate carbon in the soil) and land management practices. Besides, the Regulation promotes synergies between climate mitigation and environmental protection measures to contribute to addressing the climate and biodiversity crisis.

Member States' National Energy and Climate Plans (NECPs)[15] play a crucial role in achieving increased targets by identifying coherent policies and programmes across relevant policy areas, including land management and carbon sinks. They are responsible for caring for and expanding their carbon sinks to meet their national targets and creating synergies with other relevant policy areas. NECPs also need to explain how policies contribute to their increased ambition in the ESR, which includes agriculture non-CO_2 emissions. The role of NECPs has increased in importance, with the potential of the CAP and new CAP Strategic Plans[16] in funding and delivering meaningful change being essential factors for success.

Detailed features of the new Regulation with its two phases are shown in the Table 8.1 at the end of this chapter.

Conclusion: A separate EU LULUCF sector has been established alongside the EU ETS, with a target of removing 310 million tonnes of CO_2eq by 2030. The enhanced legal framework also focuses on improved monitoring and reporting and on maximising synergy between climate mitigation and environmental protection.

TABLE 8.1 LULUCF regulation

	1st compliance period (2021–2025)	*2nd compliance period (2026–2030)*
Target	No debit rule commitment (Article 4.1)	Increase of the net sink by 42 Mt CO_2eq, compared to the average of the period 2016–2018 (Article 4.2), distributed among Member States
Land categories	Afforested land, deforested land, managed cropland, managed grassland, managed forest land, managed wetland (optional), harvested wood products (Article 2.1)	Forest land, cropland, grassland, wetlands, settlements, other land, harvested wood products (Article 2.2)
Accounting vs Reporting approach	**Accounting approach:** Accounting rules go beyond reporting rules and involve comparing reporting values against reference values. Accounted values are assessed against the "no-debit" commitment.	**Reporting approach:** Simplified rules in comparison to accounting. Reporting involves documenting the level and development of GHG emissions and removals over time, encompassing anthropogenic and biological processes influenced by human activities, following international guidelines under the UNFCCC. Reported values are assessed against the target in the process of compliance check.
Natural disturbances accounting Emissions resulting from natural disturbances	x (Article 10) exempted from accounting under specific conditions	x (Article 13b) compensated for under specific conditions and subject to the EU achieving its target
ESR flexibility (Article 12) Member States failing to meet LULUCF targets can transfer remaining annual emission allocations under the ESR to LULUCF; and vice versa.	X	x

(*Continued*)

TABLE 8.1 (Continued)

	1st compliance period (2021–2025)	*2nd compliance period (2026–2030)*
General flexibility (Article 12) Member States exceeding LULUCF targets can transfer remaining LULUCF overachievement to another Member State needing it to meet its target.	X	x
Managed forest land flexibility (Article 13) Allows a Member State to compensate emissions from managed forest land under specific conditions.	X	
Additional compensation for Finland (Article 13a) An extra 5 Mt CO2eq of emissions may be compensated under specific land accounting categories under specific conditions.	X	
Land use mechanism (Article 13b) Applicable to Member States missing targets or budgets during 2026–2030 but conditional on the EU achieving its target.		x
Compliance deadlines	Member States must comply with the "no debit rule" for the period 2021–2025 and the compliance check will be carried out in 2027. (Article 14)	The compliance check for the 2030 target will be carried out in 2032. (Article 14)

Data Source: Regulation (EU) 2018/841[17]

8.3 Scaling Up Carbon Removals and Ensuring Credibility

The Commission proposal for a Framework Regulation on an EU-wide Certification Framework for Carbon Removals[18] aims to establish standards and procedures for certifying carbon removals, inter alia, achieved through land-use projects, such as afforestation, reforestation, forest management and sustainable agriculture practices. These certified activities can contribute to the overall mitigation efforts within the LULUCF sector. The Certification Framework also covers industrial removals, such as carbon capture and storage[19] as well as long-term carbon storage in products such as wooden buildings.

High-quality carbon removals, under this framework, are defined by stringent criteria that ensure their efficacy, long-term impact and environmental integrity. These criteria encompass:

- Quantification: Accurate measurement and quantification of carbon removals.
- Additionality: Demonstrating that carbon removal activities go beyond market practices and what is legally required.
- Storage duration: Certificates clearly account for the duration of carbon storage and distinguish permanent storage from temporary storage.
- Sustainability: Carbon removal activities should not harm the environment or should benefit other environmental objectives such as biodiversity.

Robust monitoring and accounting systems are essential to provide appropriate incentives to farmers and forest owners. To ensure adherence to EU quality criteria for carbon removals, operators of such activities must engage with recognised or Commission-approved certification schemes. Independent bodies will rigorously verify and certify the compliance of carbon removal operations with EU regulations, leading to the issuance of compliance certificates and the recording of removal units in publicly managed registries.

Based on the criteria for high-quality removals, the Commission, supported by an Expert Group,[20] will develop tailored certification methodologies for the different types of carbon removal activities.

The Carbon Removal Certification Framework's enduring potential lies in its capacity to drive widespread and impactful carbon removal practices across sectors, fostering innovative solutions and contributing significantly to the EU's climate neutrality objectives.

8.4 An Enabling Environment for Climate Action in Forestry and Agriculture

The land use sector often contributes to multiple environmental goals such as biodiversity, pollution reduction, and responsible resource management, all of

which are central to the European Green Deal. Building upon its principles, a range of EU policy developments have been set in motion to address the interplay between environmental, social, and economic aspects of land use within the EU. These policies not only promote sustainable land use sector practices but also serve as a catalyst for further climate actions within EU Member States. The following ones are of particular importance:

- EU Energy Policy: The implementation of the RES Directive and biofuels quota continue to have a major impact on the demand for sustainable biomass, and hence on the management of cropland and forests.
- The Common Agricultural Policy (CAP): While the CAP encompasses various aspects of agricultural policy, it plays a crucial role in shaping the land sector by promoting sustainable land management practices, biodiversity conservation, climate change mitigation, and rural development. It is potentially able to provide financial incentives for farmers to adopt environmentally friendly practices, ensuring the long-term sustainability of European agriculture and rural areas.
- EU Strategy on Adaptation to Climate Change: It recognises that land-related activities are vulnerable to climate change, such as extreme weather events, rising temperatures, and changing precipitation patterns, and aims to support adaptive measures in the land use sector.
- EU Biodiversity Strategy for 2030: The strategy aims to restore and protect Europe's biodiversity by 2030. This strategy recognises the interdependence of biodiversity conservation and land-related activities. It seeks to integrate biodiversity objectives into these sectors for holistic and coherent implementation of EU measures.
- Circular Economy Action Plan: It seeks to transition the EU to a more circular and resource-efficient economy. It includes measures to reduce waste, promote recycling and reuse of, for example, wood products, and minimise the environmental footprint of land-related activities.
- Forest Strategy: The strategy aims to ensure the sustainable management of forests, enhance their contribution to climate change mitigation, and protect biodiversity. It focuses on promoting sustainable forestry practices, forest restoration, and the use of wood-based products.
- Farm to Fork Strategy: The strategy aims to make the EU food system more sustainable, from production to consumption. It promotes sustainable agricultural practices to enhance carbon sequestration, reduces the use of chemical pesticides and fertilisers, and enhances biodiversity conservation in agricultural landscapes.
- Carbon Cycles Communication: The communication presents an action plan to develop sustainable solutions for increasing carbon removals and addresses key challenges related to the carbon cycle. It promotes nature-based solutions, technological advancements, and the use of

long-lasting products like wooden buildings to enhance carbon removal and storage.

- Nature Restoration Law: The Commission proposal provides a legal framework and guidelines for promoting nature restoration activities, including the rehabilitation of degraded ecosystems, reforestation, wetland restoration, and the creation of green infrastructure.
- Soil Monitoring Law: The objective of this Commission proposal is to have all soils in healthy conditions by 2050. The proposal provides for a harmonised definition of soil health and puts in place monitoring framework.
- Forest Monitoring Law: The Commission proposal establishes a comprehensive forest knowledge base through enhanced monitoring, fostering cooperation among Member States, supporting long-term forest plans, and facilitating the marketing of ecosystem services. It aims to improve the accuracy and reliability of data on forest-related parameters, which are essential for assessing the carbon sequestration potential and emissions from the LULUCF sector.
- Sustainable Finance – EU Taxonomy Regulation: The EU Taxonomy is a classification system that helps companies and investors identify "environmentally sustainable" economic activities to make sustainable investment decisions. It includes the forest sector (afforestation, forest conservation, forest management and forest rehabilitation and restauration) and the restauration of wetlands.
- Deforestation-free supply chains Regulation: The law requires key goods like palm oil, soy, timber, and their derivatives to be deforestation-free when exported or placed on the EU. Companies must conduct strict due diligence, ensuring products are sourced sustainably and comply with human rights standards. The regulation applies globally, encouraging sustainable practices and supply chain transparency.

To accelerate climate action and support the agriculture and forestry sectors, it is crucial to establish direct incentives for the adoption of climate-friendly practices. One important approach is carbon farming, which can play a pivotal role in achieving a climate-neutral economy by capturing CO_2 from the atmosphere. Several measures can be implemented. The first is the Common Agricultural Policy (CAP) that supports farmers who commit to specific environmental and climate practices or investments, with income support. The Carbon Removal Certification Framework enables a business model that rewards land managers for carbon sequestration. A second element is the standardisation of monitoring, reporting and verification in view of providing a clear and reliable framework for carbon farming. The Soil and Forest Monitoring Laws put in place a solid and coherent monitoring framework for all soils and forests. These measures will

ensure transparency and trust in the carbon farming process, enabling land managers to participate with confidence. Finally, improved knowledge and advisory services are important. Land managers need access to improved knowledge, data management tools and tailored advisory services to effectively engage in climate-friendly practices. By providing the necessary support and guidance, land managers can make informed decisions and maximise the potential of carbon farming.

In addition to direct incentives, funding opportunities from various EU programmes can further support climate action in the agriculture, land use and forestry sectors. The EU's research and innovation program, Horizon Europe, allocates a specific budget of €10 billion to support projects in food, agriculture, rural development and the bioeconomy. The Mission "A Soil Deal for Europe" is a key funding instrument to support the adoption and scaling up of carbon farming practices. The new European Bauhaus aims to transform the built environment into a sustainable, inclusive and enriching space through creative, participatory and transdisciplinary approaches. It emphasises the use of wood as a sustainable material for long-lasting products. Finally, there is the EU's environment and climate instrument, LIFE, that offers support for the agriculture and forestry sectors in activities such as biodiversity conservation, improvement of air and water quality, and climate change mitigation and adaptation. LIFE projects serve as testing grounds for innovative approaches and methods related to climate-smart agriculture and land use. Successful projects can be scaled up and integrated into larger EU policies, including the CAP or national policies.

By combining direct incentives, standardised frameworks, and funding opportunities, an enabling environment can be created to drive climate action, promote sustainable land management, and encourage the adoption of climate-friendly practices in agriculture and forestry.

Conclusion: EU policies already promote sustainable practices in agriculture and forestry, with incentives under the Common Agricultural Policy (CAP), revenues from carbon farming and funding from programmes like Horizon Europe and the LIFE Program.

Conclusion

The agriculture and forestry sectors represent a growing area of attention for climate policy around the world. One reason is that they not only emit greenhouse gases but can also become an important source of removals of carbon dioxide from the atmosphere. Globally, a quarter of the planned emission

reductions by 2030 will come from the land use sector, mainly through the reduction of deforestation in developing countries.

Further reductions in greenhouse gas emissions and increasing removals will become more challenging in the EU, especially where farmers and foresters experience hotter summers and scarcer water resources. While other sectors in the EU will substantially decarbonise by 2050, a large part of agricultural emissions are due to biological processes that are difficult to be reduced to the same extent. They will constitute one-third of total EU emissions and remain inevitable residual emissions largely driven by demand for specific agricultural products especially beef and milk. In the second half of the century, when global and EU emissions will have to reduce to net zero and below, the agriculture, forestry, and land use sectors will be key to balancing the remaining emissions with sufficient removals.

The LULUCF emissions are part of the overall EU target of a greenhouse gas reduction of "at least 55%" by 2030. This sector constitutes a reinforced pillar alongside the EU Emissions Trading System and the Effort Sharing Regulation, with a specific target of 310 Mt CO_2eq of carbon removals by 2030.

It is now high time to develop appropriate policies to improve the uptake of carbon into Europe's soils and forests. As there are still many uncertain elements about the fluxes of CO_2 the land use sector generates, much attention has been paid to how to better monitor and account for these emissions. For that reason, an EU-wide certification regulation of carbon removals is being developed and will ultimately allow for rewarding of efforts by farmers and foresters to remove carbon from the atmosphere.

Notes

1 This is a review of the chapter originally drafted by Artur Runge-Metzger and Peter Wehrheim.
2 This includes introducing leguminous crops, reducing fertiliser and fuel use through precision farming, improving manure storage, enhancing livestock breeding practices, and implementing conservation agriculture techniques to improve soil carbon content, preserving grasslands, transforming wetlands and peatlands, combining agriculture with trees, afforestation on marginal lands, optimising forest use and utilising biomass for wooden buildings.
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16 CAP Strategic Plans promote a shift to a smart, competitive, and diverse agriculture that ensures food security, while also supporting climate action, preserving natural resources, enhancing biodiversity, and boosting rural economies. See https://agriculture.ec.europa.eu/cap-my-country/cap-strategic-plans_en.
17 Consolidated text: Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework, and amending Regulation (EU) No 525/2013 and Decision No 529/2013/EU. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02018R0841-20230511.
18 COM(2022) 672 final 2022/0394 (COD). Available at: https://climate.ec.europa.eu/eu-action/sustainable-carbon-cycles/carbon-removal-certification_en.
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