EUROPEAN
COMMISSION

Brussels, 15.12.2021
SWD(2021) 450 final

COMMISSION STAFF WORKING DOCUMENT

Sustainable carbon cycles - Carbon farming

Accompanying the

Communication from the Commission to the European Parliament and the Council

Sustainable Carbon Cycles

{COM(2021) 800 final} - {SWD(2021) 451 final}

Table of contents

Glossary

Term or acronym	*Meaning or definition*
CAP	Common Agricultural Policy
EAFRD	European Agricultural Fund for Rural Development
EAGF	European Agricultural Guarantee Fund
FADN	Farm Accountancy Data Network
FaST	Farm Sustainability Tool
FSDN	Farm Sustainability Data Network
GHG	Greenhouse gas
GSAA	Geospatial aid application
IACS	Integrated Administration and Control System
LPIS	Land Parcel Identification System
LUCAS	Land Use and Coverage Area frame Survey
LULUCF	Land use, land use change and foretsry
MRV	Monitoring, reporting and verification
RD	Rural development
R&I	Research and innovation

1 WHAT IS CARBON FARMING?

Carbon farming can be defined as a green business model that rewards the actors of the land sector for taking up improved land management practices resulting in carbon sequestration in living biomass, dead organic matter, and soils by enhancing carbon capture and/or reducing the release of carbon to the atmosphere.

The concept of carbon farming is new and has been introduced by the Farm to Fork Strategy that, building on the European Green Deal Communication, encourages the agriculture and forestry sectors to deliver more on climate action and calls for the setting up of the necessary incentives at land manager level. Such financial incentives can come from public or private sources or a combination of the two and reward land managers for the change in their management practices or for the achieved mitigation results. The carbon farming credits that land managers generate can be sold on voluntary carbon markets or be rewarded by public or private incentive programs and hence become an additional "product" on top of food and biomass.

The steady emerging of private carbon farming initiatives shows an increasing trend in the demand side for carbon farming credits. Actors of the bioeconomy, such as food processors, are interested in buying carbon farming credits to reduce the carbon footprint in their value chains. Further potential buyers can be public entities, companies and individuals who want to financially contribute to more climate action on land with a view to compensate for their own emissions.

The selling of carbon farming credits can create a new source of income for land managers, who can at the same time in many cases benefit from side advantages related to increased business resilience, overall higher environmental quality of their land and under certain conditions higher profitability from land yields.

The potential of carbon removals, emission reductions and protection of existing stocks varies according to bioclimatic conditions, including risk of climatic hazards, and furthermore, strongly depends on factors such as topography, soil type, and past and current land use practices. Other social, infrastructural, and economic conditions can also influence uptake and final mitigation. Although very site-dependent in application, the following are the most effective examples of carbon farming practices:

- Afforestation and reforestation in respect of ecological principles favorable to biodiversity and enhanced sustainable forest management including biodiversity-friendly practices and adaptation of forests to climate change: the planting of new trees, the restoration of degraded forests remove CO_2 from the atmosphere over many decades and possibly centuries, at the same time providing ecosystem services and enhancement of biodiversity. Implementing a change in forest management over large areas could result in a significant total additional mitigation potential and strengthen climate resilience, by significantly reduced risk of carbon losses following disturbances;
- Agroforestry and other forms of mixed farming: land use management systems in which woody vegetation (trees or shrubs) are deliberately grown in combination with crop and/or animal production systems on the same land. Agroforestry has an important role in carbon sequestration, combining significant mitigation effects with co-benefits for ecosystems and biodiversity;

- Use of catch crops, cover crops and conservation tillage: protecting soils, and enhancing soil organic carbon on degraded arable land;
- Targeted conversion for example of cropland to fallow or set-aside areas to permanent grassland;
- Restoration of peatlands and wetlands: raising the water table of drained peatlands or wetlands not only restores the hydrological balance of soils but also reduces oxidation of the existing carbon stock and increases the potential for carbon sequestration[1].

An overview of the mitigation potential of these practices is described in the Staff Working Document "Sustainable carbon cycles for a 2050 climate neutral EU".

2 CARBON FARMING AS BUSINESS MODEL: LESSONS LEARNT FROM EXPERIENCE ON THE GROUND

Carbon farming incentives can take the form of action-based or result-based schemes. In the case of action-based carbon farming, beneficiaries receive payments for implementing defined management actions, independently of the resulting impact of those actions. A typical example are the area-based payments for agri-environment-climate commitments co-financed under the common agricultural policy (CAP), where land managers benefit from CAP support for complying with very specific farming practices which have been selected by the managing authority for the assumed environmental benefits.

In a result-based approach, on the other hand, the payment is directly linked to measurable indicators of the climate benefits provided, irrespective of the precise farming practices that are applied.

Result-based incentives offer several advantages, compared to action-based incentives, for example they ensure a more targeted use of the relevant funds towards the intended climate objective and a greater degree of flexibility for land managers who are able to choose their management strategies to achieve the desired results, rather than following a set of rules. However, they also have challenge and limitations, for example the risk of non-delivery of the expected results or the potentially insufficient cover of additional costs.

To develop carbon farming as successful and attractive business model, the relevant business opportunities need to be identified, taking into account challenges and costs linked to the setting up, implementation and upscale of carbon farming schemes. To that end, the Commission published the "Technical Guidance Handbook – setting up and implementing result-based carbon farming mechanisms in the EU"[2] ("the Handbook") that explored key issues, trade-offs and design options to support a widespread adoption of carbon farming initiatives in the EU.

In particular, the Handbook analysed examples of financial incentives in the five following contexts relevant for their mitigation potential: peatland restoration and rewetting; agroforestry; maintaining and enhancing soil organic carbon on mineral soils; grasslands; livestock farm carbon audits. The Handbook highlighted the variety in the design of a carbon farming initiatives where building blocks can have different features, such as:

[1] There is a balance between CO2 removals and CH4 emissions which is closely linked to the water table that needs to be regulated.

[2] https://op.europa.eu/en/publication-detail/-/publication/b7b20495-a73e-11eb-9585-01aa75ed71a1/language-en

- objectives and definition of result indicators: existing schemes currently reward emission reductions or avoidance or carbon removals, sometimes including co-benefits for biodiversity and ecosystem restoration;

- credibility of realized mitigation: current schemes apply different principles when dealing with additionality and permanence;

- governance: methodologies, registries and evaluation requirements vary depending on the scale of the projects; for smaller, more experimental schemes and pilots, less formal governance may be less time consuming and more agile whereas schemes that aim to sell credits for balancing emissions and those accountable for spending significant amounts of public money need more formal systems of governance;

- monitoring, reporting and verification (MRV) procedures: MRV is integral to result-based carbon farming schemes, as it is the step that quantifies the impact of climate actions, but it causes a trade-off as high stringency MRV can deliver accuracy but it is associated with high costs;

- availability of necessary skills and expertise: current schemes showed that skills and capacity are needed to be continuously developed during the scheme design and operation, including for training advisers or consultants, or the development of calculator tools;

- funding: the setting up and running of result-based carbon farming schemes require considerable resources, including a multi-disciplinary team, a partnership of organisations, an adequate budget and considerable time.

All the above-mentioned aspects are usually clearly described in the rules and methodologies associated to each carbon farming initiative: whatever its nature, private or public, voluntary, or regulatory, those rules are necessary in order to ensure transparency and reliability.
Examples of existing carbon farming schemes analysed in the Handbook are described below.

Peatland rewetting

The German MoorFutures is a voluntary carbon crediting scheme, where the quality of the credits is a central aspect, as they are guaranteed by the public regional authorities. The scheme maintains its own registry and does not allow trade in credits. Particular emphasis is given to ecosystem services such as increasing biodiversity, flood protection, groundwater retention, nutrient retention.

The UK Peatland Code is a voluntary standard with the aim to restore and sustainably manage two million hectares of UK peatlands by 2040. Eligible project areas must be classified under the condition of drained or actively eroding peatland with a minimum depth of 50 cm. The Peatland Code Field Protocol identifies baseline categories for eligibility.

The Dutch Green Deal was initiated by the Dutch Government with input and involvement from 17 private stakeholders. There are three eligible activities for consideration in the program including raising water level to 20 cm under extensive agricultural land, implementing paludicultures with cranberries or rewetting of nature to soil surface or above. These activities consider the barriers to uptake by farmers by allowing them to continue to use their agricultural land.

Agroforestry

The French CarboCage mechanism is designed to sustainably manage valuable hedges for several purposes such as erosion prevention, advanced water management and timber supply. The trial project aims to find a method of carbon storage evaluation and to potentially establish a local carbon market coupled with additional benefits, especially in the form of improved biodiversity.

The UK Woodland Carbon Code functions under local forestry authorities and serves as a standard validating and rewarding carbon sequestered in biomass. In order to generate marketable carbon credits, parties have first to comply with national forestry rules that contain minimum standards on biodiversity and sustainable management.

AGFORWARD is an EU-funded research project aiming to analyse the benefits of upscaling the agroforestry practices across Europe leading to development of rural areas. Among key deliverables the initiative has produced a widely-recognised definition of agroforestry as well as a set of leaflets covering advice on main stages of its implementation.

Montado is a result-based scheme aimed at ensuring by the use of specific indicators that adequate measures are taken to prolong natural regeneration of the system resulting in soil protection and undisturbed carbon storage.

The German CarboHedge project is focused on developing benchmarks that will help to understand levels of carbon that can be sequestered in hedgerows and field copses.

Maintaining and enhancing soil organic carbon (SOC) on mineral soils

The Austrian Humus Kaindorf program aims to test and develop practical options for SOC sequestration and increase uptake of SOC sequestration in agricultural practice, including through the generation of CO_2-certificates. Commitments should be undertaken for 12 years and there are strict eligibility criteria. No conversion of land use is allowed during the commitment period. Sampling is done at the beginning of the commitment, after 3 to 7 years and after another 5 years. The program sells CO_2 certificates to regional or national companies that aim to offset their emissions. Currently up to 500 participating farmers are included over up to 5 000 ha across Austria. The price is EUR 45 per tonne, of which EUR 30 go directly to the farmers.

The UK based Carbon Assets for Soil Health Project aims to develop an evidence base for the setting up of a reward system for public goods associated with good soil health management. In the initial three years (2020 – 2022) the project aims to develop a better understanding of the techniques and their potential to increase soil carbon sequestration and of the funding opportunities available for farmers, including of regulatory standards to maximise carbon sequestration through improved soil management. The project is crowd-sourcing data from both organic and non-organic farmers who have been monitoring soil organic matter (SOM) on their farms via an online survey, to provide insights and evidence base on the relationships between cropping history, management practices, soil types and SOM levels.

Most of the analysed carbon farming initiatives generate income through the selling of credits for the achieved emission reductions or removals. The prices obtained can be determined by markets or fixed in advance based on the costs.

The **price for carbon farming credits** can vary greatly. Experience of ongoing EU schemes, particularly on peatland restoration, has shown that prices are usually higher than those traded in the international voluntary carbon markets and that buyers are generally willing to pay higher prices to secure co-benefits in terms of biodiversity and ecosystem restoration. Based on the analysis of different types of existing carbon farming schemes, three basic approaches can be identified for the marketing of carbon credits:

- Scheme platform: the scheme operates an exclusive sale platform, selling the credits generated from different projects to different customers;
- Intermediary driven approach: individual project developers or credit off-takers help to develop the project and cover early phase costs, while securing the mandate and right to market and sell credits when these are issued. In this decentralised system, the scheme may operate a registry to help keep track of the credits, but the responsibility for ensuring their integrity is delegated;
- Exchange based approach: project developers from different schemes use a central registry and issuer to keep track of uniquely identified credits, which can be traded between buyers. This approach allows for aggregation and selling of credits from many different sectors.

Carbon farming initiatives may also take steps to reduce the market uncertainty for land managers, for example by establishing a set payment per ton of carbon sequestered over the project period. In such a case, the scheme designers set the price at a level that they can either cover from their own funds or that they expect they can recoup, for example by selling offset credits. This approach shifts price uncertainty away from land managers and places it on scheme administrators who will manage the market risks and ask for an appropriate remuneration.

Another important element is the **timing of the payment**. Ex-post result-based payments lead to increased uncertainty for land managers and can cause cash flow issues, especially where substantial up-front investment is required. Both the uncertainty and the delay between expenditure and reward can therefore constitute barriers to uptake. The analysis of existing schemes suggests four different ways around this problem, all of which involve having an ex-ante as well as an ex-post element to the payments:

(a) Separate (non-result-based) payment to cover upfront costs. Almost all schemes rely on non-market funding and support for their establishment costs, hence up-front payments could come from the same source. Possibilities for funding from public sources are described in section 3.1 below;

(b) Ex-ante payments by selling ex-ante credits. Either the buyers of these credits or the scheme operators have to accept the risk of non-delivery of the promised climate mitigation benefits. This means selling the credits at a discount, which would reduce overall income;

(c) Purchase of credits by buyers in two instalments. This approach would involve purchasers paying a proportion of the price ex-ante, with the balance payable ex-post;

(d) Hybrid scheme approach. Hybrid schemes combine elements of action- and result-based schemes, generally offering a payment to carry out a set of management actions, which is topped up if the land manager can demonstrate to have delivered additional climate benefits. Such schemes are a particularly valid alternative when the risk of non-delivery is high, as the risk is de facto shared. The majority of result-based schemes for the conservation of farmland biodiversity work on this basis, with the action-based element designed to deliver a basic level of management, and the result-based element linked to higher level biodiversity indicators that require more demanding management. This provides the 'freedom to farm' that is a major attraction of 'pure' result-based schemes. As

alternative structure, there are examples where land managers are paid up-front with a guaranteed payment, the monitoring is done at regular intervals, and the beneficiary receives a top-up at the end of the commitment period which rewards the difference between the GHG reductions corresponding to the upfront payment and the total result.

Environmental safeguards should ensure that carbon farming can respect environmental integrity, i.e. that carbon farming practices do no significant harm to biodiversity conservation and other environmental objectives. Alongside climate mitigation benefits, a large number of carbon farming initiatives are intended to produce environmental **co-benefits** or social co-benefits on the wellbeing of rural areas, but very few have so far formally incorporated co-benefits and wider sustainability into their payment structures, as this can add to complexity and costs. However, carbon farming initiatives should contribute to the financial recognition of these co-benefits because, if there is good evidence that such benefits are being delivered, this can help secure premium prices on the voluntary market. Co-benefits may also help attract funding from public bodies.

The following box summarises advantages, challenges, and limitations of result-based carbon farming schemes.

Advantages:

1. flexibility for the land manager - encouragement of adaptability, innovation and entrepreneurship;

1. clearer link between payment and mitigation impacts - higher credibility/appeal and potential for higher additionality;
2. carbon impacts are an objective effect, not a side-effect of sustainable practices - potentially higher effectiveness;
3. lower adverse selection of parcels with lower yields by farmers;
4. educational role for farmers and wider society.

Challenges and limitations:

5. potential higher financial risks/uncertainty for land managers;
6. potential higher transaction costs for developers;
7. challenges related to monitoring, reporting and verification of climate mitigation results (costs, degree of reliability/robustness);
8. challenges of ensuring additionality and of securing permanence of the carbon impacts;
9. the time needed to have results that can be measured is potentially long in the case of soil organic carbon, and in some cases the change is appreciable only after the project life span;
10. higher flexibility for the beneficiaries requires strong advisory support in the scheme design for which capacity or resources are necessary.

Financial opportunities on voluntary markets can be found through supply chain or value chain financing, i.e. when operators active in the food processing or retailing sectors want to take measures to reduce the carbon footprint of their value chain. This could be achieved through the purchase of carbon credits on the markets to compensate for the GHG emissions produced along the supply chain, or through the financing of carbon farming schemes for their suppliers (e.g. farmers). As part of the Farm to Fork strategy, the Commission facilitated the co-creation

of an EU Code of conduct on responsible food business and marketing practices[3] with stakeholders. Operators 'between the farm and the fork', such as food processors, food service operators and retailers, are encouraged to sign the Code and to voluntarily commit to undertake tangible and measurable actions to align with the objectives of climate neutrality by 2050 and contribute to achieving sustainable food systems. The code identified carbon farming, among others, as a way to stimulate sustainability in production. The Commission is also working on a proposal for framework legislation on sustainable food systems[4].

Recently, an increasing number of private carbon farming initiatives have emerged. Many global corporates and SME players pledged to achieve net-zero emissions across their full value chain by 2050 in line with the Paris Agreement recommendations, whereas others also set mid-term objectives limited to absolute cuts of the direct emissions and emissions from generated energy. On the road to reaching these goals, carbon removal solutions play an inevitable or at least compensating role to the reduction measures already underway.
Due to their strong link to the land sector, agri-food operators are particularly engaged: food and fertiliser companies work with direct suppliers as well as farmers and foresters from their value chain to promote sustainable agriculture and forest management. Pilot projects or even large-scale campaigns aim to introduce practices allowing to accurately measure and report GHG emissions as well as capture and store carbon while integrating biodiversity and yields preservation. Initiatives consist of tailored advisory with sharpened focus on conservation practices, deployment and leveraging of digital reporting tools allowing for life-cycle assessment. Alliances across the industry are formed to explore methodologies of quantifying the sequestration with MRV tools in place. Reliable data convertible into carbon credits is sought by several existing voluntary marketplaces that connect supply and demand of credits and are supported by intermediaries and financial agents using their partner networks to enhance trading.

Based on the experience gained with existing initiatives, the setting up of effective result-based carbon farming schemes requires a sound evidence base, good data, takes time, needs to actively involve the key stakeholders, including land managers, and requires adequate investment in advice and support. Nonetheless, voluntary carbon markets enable a high degree of flexibility in the scheme design so that over the recent years many carbon farming initiatives that reward carbon sequestration have emerged, opening a variety of financial opportunities.

3 UPSCALING CARBON FARMING

Despite the development of carbon farming initiatives across the EU and the increasing interest shown by stakeholders in this business model[5], carbon farming remains in its infancy. To upscale carbon farming, implementation issues need to be identified and addressed. This is particularly required as regards EU funding, also in order to address the recommendations of the European Court of Auditors (ECA) in a recent report on CAP funding[6]. The ECA findings stressed the importance of dealing with emissions from cultivated drained organic soils, e.g. by

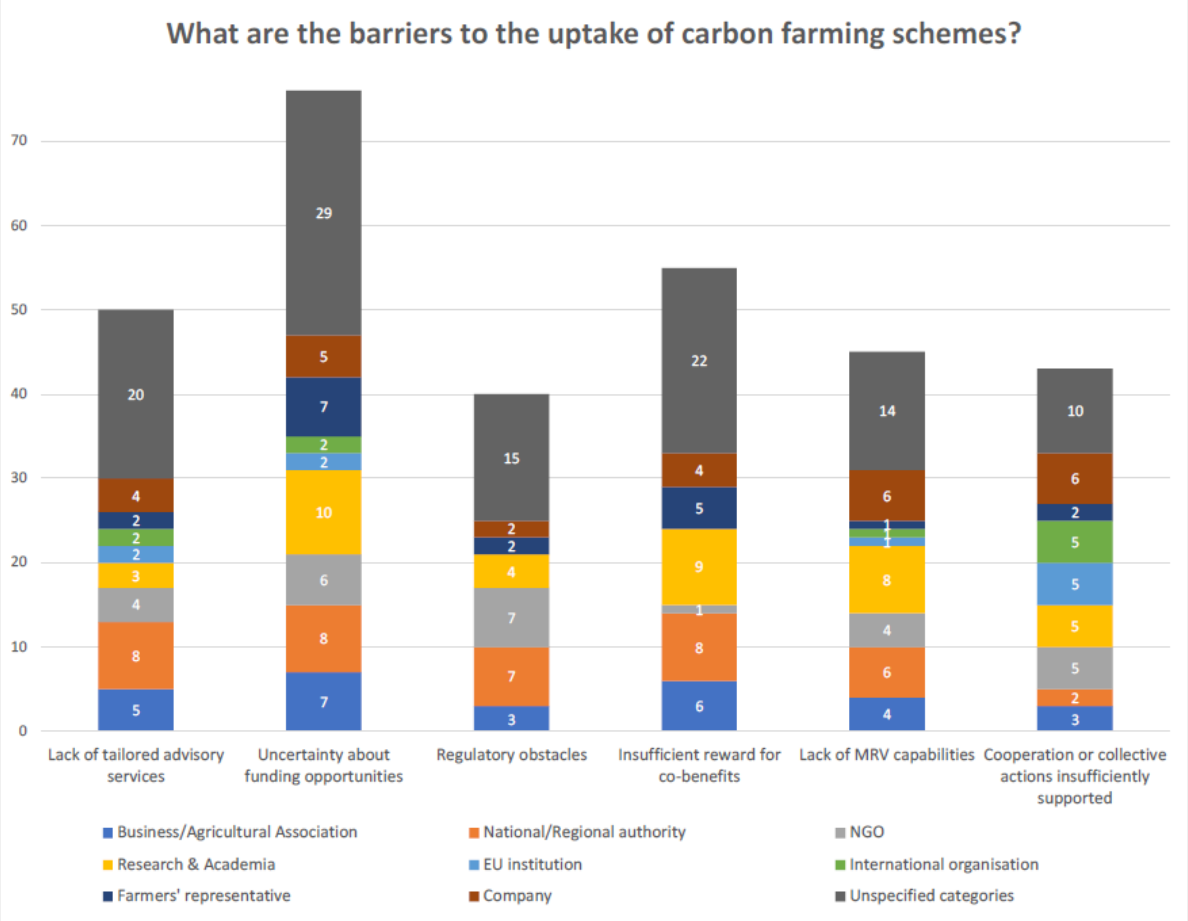
[3] f2f_sfpd_coc_final_en.pdf (europa.eu)
[4] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13174-Sustainable-EU-food-system-new-initiative_en
[5] As shown by the wide participation in numerous workshops organized by the Commission - COWI, Reviewing the Contribution of the Land Use, Land-use Change and Forestry Sector to the Green Deal (https://op.europa.eu/en/publication-detail/-/publication/8f100af5-e44d-11eb-895a-01aa75ed71a1/language-en).
[6] https://www.eca.europa.eu/Lists/ECADocuments/SR21_16/SR_CAP-and-Climate_EN.pdf

rewetting and restoration, including a monitoring system for peatlands and wetlands, which fits well to be incentivised by carbon farming schemes, as also concluded in the Handbook.

According to a recent survey[7], the main implementation challenges posed by carbon farming relate to:

- financial burden resulting from the costs of carbon farming management practices and uncertainty about revenue possibilities;
- uncertainty or lack of trust in the reliability of certification standards in voluntary carbon markets;
- complexity and high costs of robust monitoring, reporting and verification systems;
- insufficiently tailored advisory services;
- insufficient rewards for co-benefits;
- regulatory obstacles

which are confirmed by the consultation of stakeholders, as shown in the following figure[8]:



[7] COWI, p. 234 ff.
[8] COWI, p.230.

Uncertainty about funding and revenue opportunities

Although land managers are generally willing to participate in carbon farming initiatives which is confirmed by the existence of well running projects on farms, the uncertainty about the financing of the necessary costs and the profitability of the initiatives constitute major barriers to uptake. Result-based schemes are expensive in MRV, up-front investments are necessary, particularly in case of switch of land management, and high costs for measurements combined with the uncertainty about the achievement of the results make the choice of result-based carbon farming not attractive or too risky.
In order to raise land managers' awareness, knowledge campaigns about funding possibilities could be used. Public and private interaction could furthermore be considered as solution to secure revenues, whereby for instance the CAP sets minimum quality standards and provides action-based payments for the implementation of certain practices, while private markets can pay for very high-quality carbon credits (see section 3.1.4). In addition, MRV costs could be lowered by public support under the CAP or State aid, thus driving down the costs for the land manager. The certainty about revenue possibilities, particularly where based on initial action-based funding, would also likely address the general reluctance of land managers to enter too prescriptive schemes ('freedom to farm'). Possible support under public and private funding is described in section 3.1.

Uncertainty or lack of trust in the reliability of certification standards in voluntary carbon markets combined with complexity and costs of MRV systems

A commonly perceived barrier is the lack of high-quality and homogenous MRV, also to measure co-benefits for productivity and adaptation elements. In some cases, the main challenge is not the measurement itself, but rather the establishment of baselines and additionality. The need for harmonised, user-friendly, and cost-efficient tools to certify carbon removals thus qualifies as an important implementation challenge among stakeholders.
Again, public support would have the potential to address these issues in the short-term through financing for research advancements, such as in exploring the opportunities from the integration of existing databases with the increasingly available remote images, developing user-friendly GHG calculators, training in favour of land managers to invest into and learn how to use high-quality MRV tools. Opportunities for monitoring and measuring possibilities and for tools and advisory systems are described in section 3.2. However, to ensure the purchase of high-quality credits on the markets in the medium and long-term, additionality, together with well-defined rules for permanence of land-based carbon removals need to be guaranteed. To that end, the Commission is developing a credible governance system, in order to establish the regulatory framework for the certification of carbon removals based on robust and transparent carbon accounting to monitor and verify their authenticity[9].

Lack of knowledge and of tailored advisory services

A common argument of land managers for being prevented from entering carbon farming schemes is the lack of sufficient knowledge and agronomic advice on carbon farming techniques and their outcomes, also in terms of better farm management. Carbon farming can

[9] The legislative proposal is scheduled by end of 2022. See more in Commission Communication – Sustainable Carbon Cycles (section 4).

encompass different practices, from small adjustments to fully-fledged changes to the overall farming management, with corresponding different outcomes on soil and production capacity and other ecosystem services. Moreover, carbon farming techniques can be applied in different ways, depending on the pedo-climatic conditions of the farm. There are some gaps in knowledge and a general lack of homogeneity in skills, natural conditions and baselines of land managers across the various Member States.
Possible solutions to address these issues are increased and continuous support for training and advisory services. Good practices should be encouraged and their potential for carbon sequestration or emission reduction should be made known to land managers via targeted advice, for example under the CAP (including "training the trainers"). Further, the Handbook can be used as a guidance tool on how carbon farming can be effectively implemented.
Advisory services possibilities are described in section 3.2.

Insufficient consideration of co-benefits

Most practices and techniques which can be incentivized with carbon farming can have several side-benefits for other environmental objectives, such as on plant, soil and animal biodiversity and water purification. The inclusion of co-benefits in carbon farming schemes would add value to credits and reach appropriate rewards to incentivize the uptake. On the other hand, the inclusion of co-benefits poses several challenges such as the choice of indicators, the difficulty of monitoring and the insufficient financial compensation, that need to be addressed to ensure that the response to climate change is fully integrated with that to other pressing environmental and social issues, notably the continuing decline of biodiversity and the need to adapt to climate change.
It is important that carbon farming schemes embrace environmental objectives, that the no-harm principle is applied and that best win-win solutions are supported.

Regulatory obstacles

Another barrier to the effective functioning of carbon farming schemes is the existence of contradictory incentives[10] and possible conflicts among different policy objectives. One-sided approaches create imbalance between climate impact, environmental needs, administrative possibilities, and economic feasibility. This in turn creates confusion on possible interested land managers who could be confronted with scenarios where they would either need to choose which policy requirements to follow or would be hindered into adopting carbon farming practices because of conflicting EU or national legislation. Currently, for many farmers such situation is leading to the feeling of the impossibility of contributing and succeeding in all objectives[11].
To counterbalance these effects, EU and national polices could adopt an integrated approach, where policy goals would not appear as conflicting but as complementing each other. Such integrated approach should aim at achieving synergies by combining targets in the field of carbon sequestration, biodiversity, and water, with a focus on practical feasibility also taking into account the regional and pedo-climatic specificities. A stronger focus in EU and national policies on collective and multi-stakeholder approaches would also contribute to address the challenges posed by co-existing legal demands.

[10] For instance some CAP coupled support for livestock and mitigation targets under climate legal framework.
[11] INTERREG North Sea Region – Carbon Farming. White Paper "Incentivising carbon farming; policy recommendations from the Carbon Farming project" (link).

As regards CAP support, a recent evaluation of the impact of the CAP on climate change and greenhouse gas emissions concluded that a better targeting of climate demands in the Member States' instruments is needed [12]. In that regard, the new CAP has already raised the minimum climate baselines under the enhanced conditionality.

Further implementation challenges and trade-offs have been identified through stakeholders' consultation, such as the conflict between food security and the increase of non-productive land; as regards action on peatlands, the lack of identified areas in the Member States and the risk of losing direct payments in case of peatland restoration; low transaction costs; low level of compensation in the forestry sector; risk of land abandonment; effects on the land price[13]. The following sections will highlight the opportunities and potential of existing policies to address these challenges.

3.1 Public support to kick-start effective and ambitious carbon farming

As highlighted in the previous section, the uncertainty about funding possibilities for the set-up and operating costs of a carbon farming initiative combined with the risk of non-delivery of the expected results constitutes the most critical barrier to land managers' uptake. The risk of non-delivery is inherent to carbon farming schemes that link the payment to the amount of carbon benefits eventually delivered. Land managers have to invest first in new management practices and the set-up of the monitoring, reporting and verification system for the carbon credits while the revenues may only come some years later when the carbon benefit is measured and reported, making carbon farming approaches insufficiently attractive for land managers.
The public funding under the CAP and other EU programs - such as Horizon Europe, LIFE, or the cohesion funds - can support the upscaling of carbon farming, for example to cover additional costs related to monitoring, reporting and verification aspects, or to finance pilot and research projects that improve the effectiveness of carbon farming.
An additional public avenue is the use of State aid that can complement or strengthen actions covered by CAP support.
Public funding can significantly reduce the risks for land managers who are interested to enter carbon farming schemes, thereby securing their engagement.

[12] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/1408-Evaluation-of-the-impact-of-the-CAP-on-climate-change-and-greenhouse-gas-emissions_en.- The evaluation concluded that the mitigation and adaptation potential of several CAP measures could increase if:
• ploughed grassland would not be classified as permanent grassland;
• the ban on ploughing permanent grassland would be extended beyond environmentally sensitive permanent grasslands;
• small farmers would not be exempted from climate-relevant requirements under greening;
• fallow land would always be covered;
• protection and restoration of wetlands and peatlands would be enhanced;
• the level of ambition of CAP instruments/measures would increase;
• aid for areas facing natural or other specific constraints would be subject to land management requirements;
• coupled support for livestock would be targeted at extensive systems;
• support would be screened to avoid poor adaptation.
[13] COWI, p.240-241.

3.1.1 The Common Agricultural Policy

The possibility to enhance carbon sinks through afforestation, sustainable forest management, agro-forestry, soil conservation, appropriate management of carbon stocked in carbon-rich soils, gives farmers and foresters a particular role to play.
Farmers use around 40% of the total EU land area for the production of agricultural products, while forests and other wooded land cover over 43.5%[14] of the EU's land space. The CAP supports around 6.7 million beneficiaries across the European Union, representing around 85% of EU farmland[15].
For this portion of land, the CAP provides a wide range of support policy instruments that can help encourage climate mitigation, protection, and enhancement of some carbon sinks. Under the current CAP for example, in 2019 51.7 million hectares of permanent grassland were covered through direct payments and 77.7 million hectares corresponding to 74% of the EU arable land fell under the obligation for crop diversification. At the end of 2020, the overall expenditure to support afforestation/creation of woodland and the establishment and maintenance of agro-forestry systems amounted, respectively, to EUR 121 199 081 and to EUR 3 501 516.
Under the reformed CAP (2023-2027), based on a new delivery model[16], the Member States will have a larger flexibility in designing their support schemes by combining the different policy instruments within their national CAP Strategic Plans. The green architecture under the new CAP provides for different tools to support climate and environmental objectives, i.e. enhanced conditionality and eco-schemes as Pillar I direct payments and rural development (RD) interventions in the context of Pillar II.
The CAP will benefit from a budget of EUR 387 billion from two main funds: the European Agricultural Guarantee Fund (EAGF) that allocated EUR 291.1 billion for Pillar I and the European Agricultural Fund for Rural Development (EAFRD) that, including Next Generation EU funding, will make available EUR 95.5 billion for RD interventions[17].

The conditionality defines the basic standards including obligations of good agri-environmental conditions (GAEC). Several GAECs contribute directly to climate mitigation, with main objectives on the GAEC referring to preserving carbon stock (GAEC 1 - Maintenance of permanent grassland), protection of carbon-rich soils (GAEC 2 - Protection of wetland and peatland), and maintenance of soil organic matter (GAEC 3 - Ban on burning arable stubble). Other GAECs, even if not explicitly mentioning climate-relate objectives, will have beneficial effect on soil organic carbon (GAEC 5 - Tillage management reducing the risk of soil degradation; GAEC 6 – "Minimum soil cover to avoid bare soil in periods that are most sensitive; GAEC 7 - Crop rotation in arable land, except for crops growing under water). GAECs on landscape features will also represent an opportunity to increase storage of carbon in biomass (GAEC 4 - Establishment of buffer strips along water courses; GAEC 8 - Minimum share of agricultural area devoted to non-productive features or areas).
The respect of these basic standards is based on a sanction system that reduces the payment. Member States need to set their own sanction system. In the CAP 2023-2027, Member States

[14] https://ec.europa.eu/eurostat/documents/3217494/12069644/KS-FK-20-001-EN-N.pdf/a7439b01-671b-80ce-85e4-4d803c44340a?t=1608139005821.
[15] https://www.eca.europa.eu/Lists/ECADocuments/SR17_21/SR_GREENING_EN.pdf; https://ec.europa.eu/info/sites/default/files/food-farming-fisheries/key_policies/documents/factsheet-newcap-environment-fairness_en.pdf
[16] The new delivery model creates a shift from a compliance-based to a performance-based governance system.
[17] https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/new-cap-2023-27_en

can define their GAECs to better address their specific needs and situations on the ground so as to improve their effectiveness.

Eco-schemes are a new instrument introduced by the reformed CAP, constituting payments per hectare granted to farmers who undertake practices contributing specifically to environmental and climate objectives. The payment may either (i) compensate the additional costs linked to a given practice and the income foregone, or (ii) consist of an incentive payment additional to the basic income support. It can also cover transaction costs. Eco-scheme payments are in principle granted on an annual basis (but multiannual payments can be set up by the Member States for environmental purposes) and only to agricultural area eligible for direct payments. As CAP direct payments are made up-front, eco-schemes generally qualify as action-based schemes. Farmers will be paid for undertaking certain practices, i.e. actual carbon sequestration or emission reduction effects inherent to those practices will not constitute the basis for the payment. The possibility to use either forms (incentive payments or cost incurred/income foregone) for the calculation of the payment gives Member States enough flexibility to build tailored supporting schemes with a range of eligible agricultural practices beyond conditionality. In order to help Member States when dealing with this new support instrument, the Commission published a list of potential agricultural practices that can be financed as eco-schemes under the CAP 2023-2027[18].

Within the rural development interventions, payments for environmental, climate and other management commitments include, among others, agri-environment-climate commitments, support for organic farming and forest-environment-climate commitments. Support is granted for practices going beyond the baseline of legal requirements. Support for agri-environment-climate commitments and organic farming are granted per hectare. Depending on the intervention, agricultural land also beyond agricultural area eligible for direct payments and non-agricultural land can be supported. Payments are linked to multiannual commitments, but exceptions are possible: a longer period for commitments can be determined if this is necessary to achieve and maintain certain environmental benefits (e.g. commitments aimed at changing the land use from arable into nature conservation, such as creating a wetland ecosystem; or the maintenance of afforested areas). A shorter period is possible e.g. for the conversion to organic farming. Even though it is possible to establish periods for commitment that are longer than the period covered by the CAP Strategic Plans, the length of this period can be relatively limited compared to the potential timeframe required in case of carbon management.
Payments are calculated based on the costs incurred and income foregone resulting from the commitments made, taking into account the targets set. Thus, payments take typically the form of an action-based scheme that can be complemented by the financing of transaction costs. In addition, Member States will have the possibility to promote and support result-based payments schemes to encourage beneficiaries to better deliver on climate action. Carbon farming could be supported through such a result-based approach. In such scenario, payments could be based on additional costs and income foregone of the hypothetical farming practices which would be necessary to achieve the results expected, leaving freedom for land managers to choose the management practices needed to achieve the results. Result-based approaches could also be combined with action-based schemes, e.g. a scheme with management requirements offering a bonus payment in case of achievement of results, or follow a "progressive" approach, whereby results to be achieved in the first year are lower, going up progressively over the years. Other schemes use thresholds or point scales according to which beneficiaries achieving higher results receive additional payments.

[18] https://ec.europa.eu/info/news/commission-publishes-list-potential-eco-schemes-2021-jan-14_en#moreinfo.

RD interventions can also support investments for afforestation (as well as forest management measures and commitments), and the establishment and regeneration of agro-forestry systems, non-productive investments, e.g. for the restoration for wetlands and peatlands, and a wide range of horizontal measures such as:

- advisory services,
- knowledge exchange,
- training actions,
- collective and cooperation approaches and innovation actions,

which are useful to promote the early involvement of land managers, promote the uptake of carbon farming and create synergies among different stakeholders.

The described CAP instruments can be combined for increased climate effects or to better target specific land issues. Land managers would have for example the possibility to combine RD support for non-productive investments and agri-environmental-climate commitments: where non-productive investments support is provided to establish landscape features such as hedges or stonewalls but also wetland, support for agri-environmental-climate commitments would cover income foregone and additional costs linked to multi-annual management commitments carried out on those features in view of ensuring their further benefits for the environment (for instance no input around wetland to create valuable biotope). Wetland and peatland rewetting could also take the form of an eco-scheme that could be combined with payments under RD interventions to cover the income foregone and the costs of losing arable land coming from drained peatlands/wetlands for its reconversion to its original status.

In its recommendations on the CAP Strategic Plans[19], the Commission highlighted the measures that look more promising to achieve the mitigation potential in each Member State. Member States will have to ring-fence at least 25% of their direct payments budget for eco-schemes and allocate at least 35% of RD funds to measures supporting climate, biodiversity, environment and animal welfare. Overall, 40% of the CAP budget is expected to contribute to climate-related objectives.

The new CAP is particularly adapted for ensuring a basic protection of existing carbon sinks, such as carbon-rich soils with grasslands and peatlands, through the new list of GAECs, the possibility to target them to local needs and conditions, and the combination with other voluntary interventions. The sanction system based on conditionality would ensure that farmers are applying the requirements set in the GAECs, without the additional MRV burden for Member States in terms of costs and measurement obligations.
Eco-schemes and RD payments can encourage the increase of carbon stocks and protection of sinks beyond the conditionality[20]. By being able to choose different forms of support for the calculation of the payment, Member States can design tailor-made carbon farming schemes including relevant agricultural practices to respond to local farming and agro-economic conditions. This is of particular importance when the rewarding price for carbon on voluntary markets is not high enough to ensure that all costs or yield losses are covered. In this case, the support of the CAP is fundamental to ensure that practices are implemented.

[19] https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/cap-strategic-plans_en#cap-strategic-plans-recommendations.
[20] For example, for sinks that reached saturation.

Nonetheless, CAP support has also some intrinsic limitations. Firstly, a certain portion of land which is not eligible for CAP payments will remain uncovered, especially woody areas and peatlands or wetlands which are not managed by farmers, even though certain management commitments under RD can also be carried out by non-farmers (other land managers, e.g. forest managers, NGO, municipalities). The effect of practices that increase carbon stocks is hardly evident in the timeframe of the CAP. Moreover, the EU farming system is extremely diversified while verification of compliance is only done on a sample not resulting in reliable estimations of credits. Furthermore, it would still require to be planned with the involvement of farmers and national authorities, adding administrative burden. In addition, liability against carbon reversal is difficult to implement within the CAP legislative framework considering its timeframe and that possible estimations of carbon sequestered would only serve for policy monitoring purposes at EU level, with the exception of specific result-based schemes within individual CAP Strategic Plans. This would not be sufficient to ensure contractual guarantees for carbon credits to be sold on the markets. The legal framework and administrative arrangements underpinning the implementation of the CAP may pose limits to the design of essential elements such as MRV, governance, liabilities, carbon registers, targeted services etc., which in addition may risk imposing an excessive administrative burden for management authorities. The control and sanction system[21] foreseen for CAP payments cannot ensure the level of accuracy, liability and responsibility required for the selling of carbon credits on the markets, as the contractual conditions required for generating carbon credits would be constrained by the CAPs specific legal, financial and administrative arrangements.

3.1.2 Support under other EU funds

Carbon farming can be supported also through EU programs that can for example finance the costs related to monitoring, reporting and verification aspects, or pilot and research projects that improve the effectiveness of carbon farming and foster collective and cooperative approaches. Particularly relevant for upscaling carbon farming elements is research and innovation, that can be supported under Horizon Europe. In the light of the potential of future initiatives under Horizon Europe for improved technologies for MRV, opportunities under this program have been described in section 3.2.2 below.

LIFE budget can complement CAP funding, for instance to help set up and run the necessary governance pillars (advisory systems, methodology development, partnership building), or to test and pilot local initiatives that can then be scaled up via the CAP. The Commission is setting a main focus on carbon farming in the annual calls for projects:

- CARBON Farming[22], testing a result-based mechanism in mixed crop livestock systems with the objective to reduce the carbon footprint of the project agricultural products by 15% in 6 years, with attention to monitoring, reporting and verification as well to training, advisory and knowledge needs;
- Carbon Farming Scheme[23], testing an incentive scheme enabling the trading of removal certificates;

[21] Integrated Administrative and Control Systems of Member States (see section 3.2.1).
[22] https://webgate.ec.europa.eu/life/publicWebsite/project/details/5567
[23] https://www.st1.com/st1-life

- CO2PES&PEF[24], promoting the enhancement of forest systems through different ecosystem services to increase carbon stocks;
- +REB[25] intended to provide and implement a new climate forestry in the oak forests of Castile and León, to enhance removals in forests and wood products (expected 510 tonnes/year of CO2 sequestered during 4 years), at the same time enhancing adaptation and biodiversity;
- MULTI PEAT[26] aimed at restoring or improving 689 hectares of degraded peatlands and at developing strategies for paludiculture and its practical implementation;
- 3 dedicated preparatory projects to start in 2021 focusing on better monitoring tools.

Cohesion funds and in particular the Just Transition Fund support the social, economic, and environmental challenges of Member States stemming from the phasing out of fossil fuel-related activities or decarbonising GHG-intensive processes or products. As the Just Transition Fund will support regions relying heavily on peat extraction in their transition away from fossil fuels, this could a relevant instrument for example for the restoration and conservation of peatlands, which is one of the most effective carbon farming options.
Several transnational INTERREG projects were co-founded through the European Regional Development Fund, some which have a clear focus on carbon farming:

- North Sea Region Carbon Farming[27] developed four carbon farming business models with a view to supporting farmers' participation: within the agri-food chain, outside the agri-food chain, at farm level and including public institutions;
- North-West Europe Carbon Connects[28] supports the shift towards low carbon land management practices in the European North-West peatland regions.
- Geco2[29] introduces innovative measures to monitor and offset CO2 emissions through effective cross-border cooperation.

3.1.3 State aid

Member States might consider supporting carbon farming initiatives through pure national financing, i.e. State aid, to reduce net GHG emissions from the land use sector and meet targets under the LULUCF Regulation.
EU competition rules require Member States intending to grant aid to either notify the Commission with their State aid schemes or to cover their aid through a block-exemption regulation[3031].

[24] https://lifeco2pefandpes.eu/en/objectives/
[25] https://webgate.ec.europa.eu/life/publicWebsite/project/details/5565
[26] https://webgate.ec.europa.eu/life/publicWebsite/project/details/5563
[27] https://northsearegion.eu/carbon-farming/
[28] https://www.nweurope.eu/projects/project-search/cconnects-carbon-connects/
[29] https://www.italy-croatia.eu/web/geco2
[30] Whenever the Commission has sufficient experience, it can adopt block-exemption regulations that exempt the given aid from the formal notification procedure with the consequence that block-exempted aid only needs to be submitted to the Commission, without the necessity of a formal approval decision.
[31] Member States can also grant de minimis aid under certain conditions. However, such funding, in the light of the lack of impact on competition and trade, is not considered to be State aid.

The existing instruments for the agricultural and forestry sectors are the European Union Guidelines for State aid in the agricultural and forestry sectors and in rural areas 2014 to 2020[32] and the agricultural block-exemption regulation[33].
This State aid framework has already tools in place to contribute to environmental and climate performance. The aid measures that are particularly relevant for Member States to support their increased climate ambition are indicated in the table below[34].

Agriculture	**Forestry**
Investment aid for: - sustainability of agricultural holdings - improvement of the natural environment, hygiene, and animal welfare standards, beyond Union standards - infrastructure related to supply and saving of energy and water - achievement of agri-environment-climate objectives, including biodiversity, Natura 2000 and other high natural value systems. Aid for agri-environment-climate commitments and animal welfare commitments Aid for disadvantages related to Natura 2000 and Water Framework Directive Aid for organic farming Aid for cooperation for joint actions undertaken with a view to mitigating or adapting to climate change	Investment aid for: - afforestation and creation of woodland - agro-forestry systems - improvement of the resilience and the environmental value of forests ecosystems Aid for disadvantages related to Natura 2000 forest areas Aid for forest-environment, climate services and forest conservation Aid for maintenance and restoration of forest ecosystems, biodiversity, and traditional landscapes Aid for maintenance and improvement of soil quality and balanced and healthy tree growth Aid for restoration and maintenance of natural pathways, landscape elements and features and natural habitat for animals Aid for cooperation for joint actions undertaken with a view to mitigating or adapting to climate change
Non-agricultural activities in rural areas	
Aid for agri-environment-climate commitments to land managers not active in agriculture Aid for disadvantages related to Natura 2000 areas to land managers not active in agriculture Aid for cooperation for joint actions undertaken with a view to mitigating or adapting to climate change	

State aid rules apply in principle to agriculture and forestry also with regard to CAP support. With regard to agriculture, the legislator has nonetheless decided that payments to farmers included in RD programs (and the future CAP Strategic plans) do not require a further assessment by the Commission. On the contrary, any aid for forestry measures regardless whether funded as pure national financing or in the CAP Strategic plans, must be approved or block-exempted by the Commission (State aid clearance).

[32] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02014XC0701(01)-20181109
[33] Commission Regulation (EU) No 702/2014 of 25 June 2014 declaring certain categories of aid in the agricultural and forestry sectors and in rural areas compatible with the internal market in application of Articles 107 and 108 of the Treaty on the Functioning of the European Union (OJ L 193 of 1.7.2014, p.1).
[34] Evaluation of the instruments applicable to State aid in the agricultural and forestry sectors and in rural areas (SWD(2021) 107 final of 11.5.2021).

Member States have been widely using State aid to support schemes with green objectives[35]. Nonetheless, there is scope for strengthening the incentives for farmers and foresters to undertake carbon farming practices.

The current State aid framework for the agricultural and forestry sectors does not cover result-based schemes for carbon sequestration and storage. Climate-friendly practices on soil and forest management that can qualify as carbon farming could be supported through the aid measures indicated in the table above, in particular through aid for agri-environment-climate commitments, aid for forest-environment, climate services and forest conservation or investment aid for afforestation and creation of woodland, for agro-forestry systems or for the improvement of the resilience and the environmental value of forests ecosystems. However, these measures proved not to be sufficient to create the necessary incentives to support adequately climate action[36]. Aid for agri-environment-climate commitments and for forest-environment, climate services and forest conservation is currently limited to compensation of the income foregone and the additional costs that land managers incur for undertaking climate-friendly activities, without any incentives going beyond such compensation.

The revision of the current agricultural and forestry State aid rules that must enter into force at the beginning of 2023 is an opportunity to address the implementation challenges described above. The introduction in the Guidelines of aid for result-based schemes in the agricultural and forestry sectors can support the development of carbon farming initiatives, leading to financial opportunities for its actors. Through these new possibilities public authorities will have targeted tools to contribute to their climate goals or to provide State aid clearance to result-based approaches in co-financed forestry schemes.

The extension of the scope of the agricultural block-exemption regulation to cover forestry measures financed by pure national money, or the possibility under the Guidelines of incentive payments for forest-environment and climate services could furthermore create an additional leverage effect to support carbon farming.

3.1.4 Combined approaches for carbon farming

While private markets are a clear avenue for the setting up of pure result-based schemes, their effectiveness and long-term price stability depend on proper support from either private or public sources. Based on the analysis of existing private initiatives, result-based carbon farming schemes without some form of ex-ante payments to land managers seem unlikely to attract sufficient uptake. To that end, public and private funding instruments can be combined to create stronger incentives and a synergic approach to address the limitations or weaknesses linked to a specific funding instrument.

To find the optimal combination of support, it is important to take into consideration the objective of the scheme: whether it is aimed at carbon sequestration or emission reductions will likely influence the choice of the most suitable financing instrument. Another element to

[35] For instance, in the period July 2014 to August 2020, Member States notified or exempted 62 measures for agri-environment-climate commitments, 35 measures for forest-environment climate services and 55 measures for afforestation. These three categories of State aid measures alone disbursed in the period 2014-2018 EUR 1 315 million, representing some 8% of total State aid expenditure under the current rules in this period ((SWD(2021) 107 final of 11.5.2021, p.28).

[36] During the public consultation to support the "Evaluation of the instruments applicable to State aid in the agricultural and forestry sectors and in rural areas" (SWD(2021) 107 final), around 60% of respondents considered climate change mitigation and adaptation to be objectives pursued by the granting of State aid of very high importance, whereas only 36% of respondents found that aid to the agriculture sector had until present contributed to climate change mitigation and/or adaptation.

consider are the limitations of the different sources of financing, in order to target support to cover the different necessary elements of a carbon farming scheme in the most effective way.
As mentioned in section 3.1.1, the reformed CAP has the potential to incentivize carbon sequestration and to ensure the protection of sinks that reached saturation, e.g. after some years in a carbon accumulation scheme. However, with regard to result-based farming schemes, the CAP poses several limitations linked to its duration and lack of the necessary mechanisms to ensure a high degree of robustness, reliability, verification, and liability to prevent reversal of sequestered carbon. Result-based carbon farming requires also a more sophisticated governance and service infrastructure, which the CAP may help to set up but not entirely ensure.
State aid financing or private carbon farming initiatives can offer additional and, in some cases, more performing mechanisms. Additional revenues from carbon markets or higher budget under State aid can make an important difference.

Example of different support avenues – The Danish peatland schemes

DK peatland restoration and rewetting

Primary objective is to reduce CO2e emissions from carbon rich organic soils through the rewetting and restoration of soils with > 6 % organic carbon.
Potential: total area of cultivated organic soil in Denmark: 170.000 ha = 7 % of the total cultivated area.
The Government proposal towards 2030 is to restore, rewet or set aside at least 100 000 ha of carbon rich peat soils for an expected climate effect of 0,8m tons CO_2e in 2030.
Landowners are compensated for the loss of income through different instruments:

(a) CAP RD support
(b) Two schemes 100% financed under State aid (SA.57978 (2020/N) and SA.58791 (2020/N)
(c) Climate-Forest Fund financed through national funds.

The CAP, private schemes and State aid can act in complementary mode. This will have the effect of reducing risks for land managers which is crucial to increase uptake. As highlighted in section 2, this could be achieved through different strategies, e.g. through the use of hybrid schemes, where land managers receive a basic action-based payment for employing climate-friendly management practices (be it under the CAP or State aid) and an additional result-based payment if climate benefits can be demonstrated; or else through a combination of payments under CAP RD interventions or State aid and result-based revenues coming from the sale of credits on private markets, after addressing double-funding concerns.

Example of result-based private/public carbon farming scheme – The French Label Bas Carbone

The Label Bas Carbone (Low Carbon Label) is an arm of French Ministry of Ecological Transition that provides a transparent framework for funding local projects to reduce GHG emissions and increase carbon removals, by rewarding behaviors that go beyond usual practices. Projects that on a voluntary basis ensure such additionality, but also quality and environmental integrity, can be offered guarantees and direct financing.
To benefit from the Label, projects must refer to a method previously approved by the Ministry. So far, 11 methodologies have been developed, out of which 3 for forestry and 6 for agriculture. They specify for a given type of project how the baseline is to be determined and how the emission reductions/removals are to be calculated. Approved methodologies provide for different durations of the responsibility window. Emissions reductions are calculated for the entire period of the project, but they are issued by anticipation at year 5 when a verification is performed by an independent third party. The results achieved through the projects are then certified and recorded in the dedicated register, where they can be accessed by the potential private funders.
Approved methodologies also introduce discounts that can be applied at each step of the calculation to compensate for different uncertainties, whether they are related to the lack of

CAP support or State aid would hence constitute a fundamental source of financing to cover the costs of setting up a carbon farming scheme including investments, targeted advisory services, collective and cooperative approaches, training for in-farm, soil sampling and analysis, transaction costs, investment on new machinery, measurements, and verifications costs of MRV tools that would facilitate land managers to enter in pure result-based carbon farming schemes. Land managers would then benefit from the revenues sold through private schemes that would provide the contractual requirements and guarantees, including governance and trade management of the credits. This could especially be justified if the activities for increasing the sinks are costly as compared to the rewards that the market may provide (when CO_2 price is still low). Due to the time needed to generate and correctly measure carbon removals, the different forms of CAP support will be decisive in order to support farmers and foresters in building up their carbon removal business.
In all cases where different sources of finance are being used it is important to avoid double funding, for example when a result-based carbon farming scheme is operating in parallel with another environmental land management scheme, since an individual management action may have multiple benefits and might be rewarded through more than one scheme. The CAP architecture provides for strict requirements for cross checks to avoid double funding on schemes run using CAP funding. Similarly, State aid financing is subject to rules on cumulation so that even for combined support any double funding should be avoided.
In light of the above, it is possible to conclude that there exists an important financial complementarity and a high potential for synergies between CAP support, private schemes, and State aid for carbon farming initiatives. The CAP or State aid can create the right conditions for a private scheme to develop, help wider land managers' uptake, secure their long-lasting engagement, and help operate more conveniently and efficiently.

Synergies of funding under the CAP, private carbon farming initiative and State aid

	CAP	Private markets	State aid
Design elements			

Governance	CAP structure	Possibility to put in place several and suitable governance structures and build a chain of service suppliers	More flexible than under the CAP, but has to follow State aid procedures
Eligibility	Limited to CAP rules on eligible lands and beneficiaries	All lands, potentially also other actors, such as public and private forest owners	Flexibility allowed through EU ex ante checks
Payments	Hectare-based payments, cost incurred and income forgone. Practices can be used as proxy for the quantification of carbon sequestered. Possibility for result-based payments under Rural Development. Not possible to have a homogeneous payment system across the EU.	With a regulation in place, homogeneous system across the EU	Result-based payments for carbon units sequestered. Budget allocated can be higher than under the CAP.
Monitoring Reporting Verification	Limited in setting robust MRV for result-based payments and the estimation of carbon credits. Verification capacity is limited. Possibility to support the use of MRV tools, knowledge transfer, soil analysis, transaction costs.	Robust MRV system is possible. Carbon credit calculations are basic requirements and embedded in private schemes.	Possibility to combine support for the use of MRV tools as aid for knowledge transfer with aid to cover MRV as transaction costs. Verification to take place through annual reporting
Baseline	Based on practices, defined by conditionality and the payments for eco-schemes and rural development.	Can be assessed by the definition of carbon fluxes at the beginning of the scheme.	Based on practices, rules mirror CAP conditionality
Permanence	Eco-schemes and RD can set multiannual contracts within the CAP programming period. Not possible to establish long periods with liabilities.	Ensure long-term permanence in line with standards. Include mechanisms to deal with intentional and unintentional carbon reversals	Limitation to multi-annual payments up to the duration of the State aid instrument (normally seven years)

3.2 Improving monitoring, reporting and verification (MRV) methodologies, data management and tailored advisory services to land managers

Providing land managers with improved knowledge, tools and methods for a better assessment and optimisation of the carbon benefits is key for cost-efficient implementation of mitigation action and to securing their engagement in carbon farming. This is particularly relevant for European small farmers or forest holders that often lack know-how and expertise for adjusting their businesses, face important administrative burdens and the complexity of required measurements and monitoring. The CAP and State aid can finance advisory services,

knowledge exchange, training, information actions or interactive innovation projects with farmers and foresters.
A strengthened Agricultural Knowledge and Innovation Systems (AKIS) will be part of the new CAP Strategic Plans. It will gain from the links among research, innovation and knowledge-sharing under the Horizon program and the CAP with the European Innovation Partnership for agricultural productivity and sustainability (EIP-AGRI) and its growing numbers of Operational Groups and Focus Groups, some of them already testing and analysing carbon farming elements. In this context, Member States must ensure advice and knowledge transfer on a broad number of domains, including environmental ones which may serve for the purpose of carbon farming.
Such EU and national financing can also support cooperation approaches and the establishment of producer organisations that could facilitate the provision of relevant knowledge through technical advice to their members.

3.2.1 Boosting user-friendly tools and database integrations

User-friendly on-farm calculation tools have great potential for helping land managers to engage in carbon farming schemes. Such tools facilitate MRV, detect areas with high mitigation potential (by emission reduction or enhanced removals) and assist in selecting the most appropriate mitigation strategy. They integrate existing databases, compare the land manager's performance against past averages or common/default benchmarks, and facilitate tailor-made expert advice. Moreover, methodologies and data improvement often proved to be a significant factor to affect changes in the land sector.
Carbon farming support tools and MRV systems should be based on existing data sets, surveys, inventories and tools. Target developments, such as higher granularity of data in space and time, for carbon budget accounting or monitoring land management practices may be needed. By implementing carbon farming this way the Commission ensures a cost-effective implementation via two avenues:

- the overall development costs are lowered as carbon farming benefits from already existing data and tools with no additional investments but additional benefits for carbon farming land managers;

- developments or improvements specifically made for carbon farming, e.g. with regards to granularity and accuracy could also feedback to existing policies, such as on improving GHG inventories of Member States, and possibly into new ones, thus trigger cross fertilization among different policy fields with shared additional investments.

Under the reformed CAP, Member States will need to implement by 2024 the Farm Sustainability Tool for nutrients (FaST) within the elements covered by Farm Advisory Services. The Commission may provide support to the Member States in the design of the FaST, in order to ensure a level playing field between farmers and across the Union. The Commission is working on the integration of a module for the calculation of GHG balance at holding level, complementing the assessment of the nutrient balance.
Besides improving the accuracy of inventory data, digital technology will be essential to develop granular and site-specific monitoring of carbon farming actions. For example, the period that carbon is stored in soils and plants is an important prerequisite in ensuring permanence of the mitigation measure. In particular EU SMEs will play a critical role in the

continued development of tools and services for carbon farming monitoring and providing innovative solutions for agricultural monitoring overall.

Several tools are available or under development that could improve the quality and further reduce overall MRV costs. For agricultural land falling under the scope of the CAP, the Member States are required to establish and operate an integrated system, known as Integrated Administration and Control System IACS (notably the geospatial aid application used by the CAP beneficiaries) to manage and control CAP payments. It provides for regular and systematic observation, tracking and assessment of agricultural activities and practices and the monitoring using Copernicus Sentinels (or other, equivalent) satellite data (currently known as Checks by Monitoring and as Area Monitoring System in the next CAP).

This specifically includes geographically explicit data of agricultural parcels in Member States, the Land Parcel Identification System or LPIS, and geospatial aid application (GSAA). The systems as a whole are a very strong database that should serve the implementation of carbon farming and its MRV. The Commission will continue through the IACS data sharing exploring with Member States new ways to solve interoperability issues and facilitate relevant data sharing across the EU[37].

The Land Use and Coverage Area frame Survey (LUCAS), a Commission initiative, is the first systematic sampling of soil organic carbon across the EU. It applies one a harmonized methodology with an approximately three-year revisit cycle which holds the potential to spatially extrapolate soil carbon with a good approximation and could serve to assess trends and developments when more measurements become available.

Moreover, the Commission will continue its support to develop remote sensing-based methods for annual monitoring of greenhouse gas emissions and removals from land. This work will have the potential to improve for example mapping and monitoring of peatland and wetland areas, thus contributing to the implementation of carbon farming on such highly priority areas for climate and biodiversity.

Peatlands and organic soil areas, in particular, are not evenly distributed across the EU, and many countries do not have recent soil mapping information. Therefore, before making decisions on fallowing organic soils, first reliable soil information must be obtained. In Member States where soil mapping has not been conducted recently, old soil data can provide wrong information as the organic soil might be oxidized already.

Nonetheless, the role of Member States in improving monitoring on the ground remains important, at least in the first years of monitoring system development for calibration purposes.

As part of the Farm to Fork strategy, the Commission will propose to convert the Farm Accountancy Data Network (FADN) into a Farm Sustainability Data Network (FSDN), with a view to expand the collection of data to also serve environmental policies such as assessing targets of the Biodiversity Strategy and supporting sustainability indicators. The initiated work for including more variables linked to environment and climate will provide the possibility to collect more activity data from representative farmers in the EU.

Forest monitoring systems mainly build on field-based observations such as national forest inventories and in a few cases also specific national forest soil inventories. Most of those systems are based on regular systematic sampling grids with revisits every 5 to 10 years. Forest inventories are then updated, either by adding new data annually, e.g. update 20% of the plots for a five-year revisit cycle, or once the revisit has been completed for all sites, i.e. after five years. Forest inventories and forest soil inventories measure a wealth of parameters ranging from general environmental conditions to specific elements on biodiversity and climate.

[37] The Commission launched the 'IACS data sharing under INSPIRE process' to ensure better discoverability, efficient access (single entry point) and effective re-use of spatial IACS data (interoperability and use cases) in a coherent policy environment.

On-site visits, sampling, parameters assessment possibly followed up with laboratory analysis make such systems inherently expensive. For instance, in metropolitan France, the national forest inventory directly mobilizes about 91 full-time jobs and represents an estimated budget between EUR 8.2 and 10.4 million (2020 campaign)[38]. Such elevated costs – for manifold applications in forestry, including the forest industry, environmental monitoring, and ecosystem assessment with a multitude of societal benefits – and practical limitations make more frequent revisits, e.g. annual revisit of all plots, prohibitive. Besides the bottom-up measurements taken in national inventories, top-down approaches, for instance by remote sensing, can complement forest information. High frequency image acquisition provides comprehensive and harmonized information about the state of the land and thus contributes to densifying information on forests in space and time. For instance, Copernicus[39] Sentinel 2A and 2B revisit the whole globe every 5 days with a spatial resolution of 10m and acquiring information in the optical and thermal domain. Radar systems like Sentinel 1A and B complement and enrich this data set independent of atmospheric conditions and have the potential to reveal the forest structural parameters by penetrating the canopy.

In many ways, the richness in such systems based on remotely sensed data holds an untapped potential for operational forest monitoring. Remote sensing can close the gap in the frequency for forest observation going from 5 to 10 year intervals in ground based inventories to annual data. Even more, remote sensing provides insights into the seasonal development of forests[40] and which may serve as an early warning for adverse effects or anomalies compared to the long term average conditions or as a means to assess trends in seasonal developments as a consequence of climate change or other regional drivers for a changing environment. Satellite imagery also provides a higher grid density (e.g. 10 m) through a coherent set of information across large areas (also known as wall-to-wall approach) compared to the distance of several km between ground-based sampling plots. Linking the high spatial resolution of satellite imagery with ground based observation networks holds the potential to bring sample-specific information into space.

The uptake and use of remotely sensed information for timely, operational monitoring lags behind the developments in the agriculture sector under IACS and GSAA. Therefore, the Commission strengthened the monitoring requirements in the proposal for a revised LULUCF Regulation[41] and announced in the New EU Forest Strategy for 2030 its intentions to put forward a legislative proposal on EU Forest Observation, Reporting and Data Collection[42], which would also enable carbon farming to benefit from inventory based and remotely sensed information.

[38] Commission Territories of the National Council for Statistical Information. Meeting on 20 May 2021. Fiche descriptive for an application for an opinion of opportunity. National Forest Inventory Survey. https://www.cnis.fr/wp-content/uploads/2021/01/Enqu%C3%AAte-Inventaire-forestier-national.pdf.

[39] https://www.copernicus.eu/en

[40] EEA vegetation phenology.

[41] Proposal for a Regulation of the European Parliament and of the Council amending Regulations (EU) 2018/841 as regards the scope, simplifying the compliance rules, setting out the targets of the Member States for 2030 and committing to the collective achievement of climate neutrality by 2035 in the land use, forestry and agriculture sector, and (EU) 2018/1999 as regards improvement in monitoring, reporting, tracking of progress and review (COM(2021) 554 final of 14.7.2021, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021PC0554).

[42] New EU Forest Strategy for 2030 (COM/2021/572 final of 16.7.2021, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0572)

3.2.2 Role of research and innovation

Research work is still necessary in several areas, such as measuring actual fluxes, deriving a diversified set of emission factors reflecting the complexity of the interaction between practices and local conditions, as well as integrating these factors and soil sampling in models. It will also be important to explore the potential of remote sensing and new measuring instruments, integrate existing local databases built under diverse policy contexts, and analyse different methodologies in order to have a single, comprehensive monitoring and certification system for carbon farming in the Union. Furthermore, Innovation actions under Horizon Europe offer an opportunity for testing and demonstration of large-scale carbon farming projects within the Union territory.

Horizon Europe's research and innovation activities

In line with the EU Green Deal objectives, Horizon Europe and its thematic clusters, in particular Cluster 6 "Food, Bioeconomy, Natural Resources, Agriculture and Environment" and Cluster 5 "Climate, Energy and Mobility", will support research and innovation (R&I) activities in the area of carbon sequestration and the preservation of carbon stocks. Targeting climate neutrality, they will help to deploy and optimise solutions based on ecosystems, while supporting biodiversity and providing renewable resources for a circular and sustainable bioeconomy. Horizon Europe will hence be a powerful tool in the upscaling of carbon farming as it will contribute to:

- the progress in the certification and authenticity verification of carbon removals from ecosystems;
- advancement in soil carbon stock changes monitoring, remote sensing and modelling;
- the creation of a knowledge platform intended to share information on relevant research activities and their outcomes concerning methodologies for soil carbon balance monitoring, and practices increasing soil carbon;
- promoting agroforestry as a sustainable farming practice that can foster climate change mitigation and carbon sinks in the primary sector (including development and demonstration of practical examples);
- increased forest-based carbon removals through forest management practices and uses of long-lived wood products;
- strengthening the ocean-climate nexus by reinforcing the understanding of the natural ocean carbon sinks and their potential;
- the restoration of natural wetlands, peatlands, and floodplains, through rewetting as well as paludiculture;
- defossilisation of farming, through land-use strategies and rewilding landscapes for carbon sequestration.

The Work Programme for 2021-2022 of Horizon Europe's Clusters 6 and 5 include several calls for carbon farming-relevant topics. This is the case for example of:

- HORIZON-CL6-2021-CLIMATE-01-04: Demonstration network on climate-smart farming – linking pilot farms;
- HORIZON-CL6-2021-CLIMATE-01-08: Agroforestry to meet climate, biodiversity and farming sustainability goals;
- HORIZON-CL6-2021-CLIMATE-01-09: Enhancing science-based knowledge on the EU's forests, including old-growth forests, capacities to mitigate climate change;

- HORIZON-CL6-2021-BIODIV-01-05: The economics of nature-based solutions: cost-benefit analysis, market development and funding;
- HORIZON-CL6-2022-BIODIV-01-06: Monitoring and effective measures for agrobiodiversity;
- HORIZON-CL5-2021-D1-01-08: Restoration of natural wetlands, peatlands and floodplains as a strategy for fast mitigation benefits; pathways, trade-offs and co-benefits;
- HORIZON-CL5-2021-D1-01-09: The contribution of forest management to climate action: pathways, trade-offs and co-benefits;
- HORIZON-CL5-2022-D1-01-03-two-stage: Social science for land-use strategies in the context of climate change and biodiversity challenges;
- HORIZON-CL5-2022-D1-02-05: Let nature help do the job: Rewilding landscapes for carbon sequestration, climate adaptation and biodiversity support.

The Horizon Europe mission "A Soil Deal for Europe" creates a network of 100 living labs and lighthouses to lead the transition towards healthy soils by 2030. This goal is substantiated with eight specific objectives that address: soil carbon sequestration and protection, soil degradation, the protection and restoration of soil ecosystems and soil biodiversity, soil sealing, pollution and erosion. Innovations in carbon farming, soil pollution (including pesticides) mitigation and restoration, soil biodiversity and the circular economy will be given special attention. R&I will be key to increase the understanding of basic processes, drivers and mechanics that affect soils as well as to deliver solutions for more sustainable soil management. Carbon farming has been identified as a priority, therefore, the mission is well placed to fund R&I, testing and demonstrations in this area. More fundamental R&I on soils will support the emerging carbon farming business on ecosystems by developing robust, ready-to-use, harmonised indicators and methods for carbon measuring, monitoring and certification as well as supporting the development of incentives, business models and advisory services. As a result, the development and tracking of low carbon products across value chains will be enhanced.

The Commission will work to set the focus on carbon farming also in the coming Soil Mission's and Clusters 6 and 5's Work Programmes, in particular the ones for 2022 and 2023-2024.

The proposed European Partnership "Accelerating farming systems transition: agroecology living labs and research infrastructures"[43] has an objective to consolidate a network of living labs and research infrastructures that will accelerate the transition towards agroecology throughout Europe. It will deliver ready-to-adopt tools that are going to support farmers in understanding and implementing agroecological practices. The Partnership will start in 2023-2024.

The European Innovation Council's (EIC) Accelerator is a funding instrument associated with Horizon Europe, dedicated for SMEs and start-ups that develop breakthrough innovation projects with high growth potential, which is associated with Horizon Europe. The EIC Accelerator Challenge "Technologies for *Fit for 55*" supports the development and upscaling of sustainable agriculture to increase climate resilience, abate nitrogen and methane emissions and increase carbon stock in the soil.

[43] https://ec.europa.eu/info/research-and-innovation/research-area/agriculture-forestry-and-rural-areas/partnership-agroecology_en

European Innovation Partnership for agricultural productivity and sustainability (EIP-AGRI)

The European Innovation Partnership for agricultural productivity and sustainability (EIP-AGRI)[44] is a major policy and networking initiative designed to close the gap between research and practice and to speed up innovation on the ground.

The EIP-AGRI is based on an interactive innovation model which promotes collaboration between various actors (farmers, foresters, entrepreneurs, product users, consumers, researchers, etc.) to identify the end-users' needs and make best use of complementary types of knowledge in view of co-creation and dissemination of solutions ready to implement in practice.

Around 300 Operational Groups (OG) work on innovative solutions to address challenges related to soil management. EIP-AGRI's financial support to OGs working on soils in the period 2014-2020 amounted to about EUR 90 million or even EUR 200 million when taking into account projects focusing on fertiliser applications and nutrient management, or on land and landscape management. Under the CAP 2021-2027 the number of OGs dealing with soil-related issues is expected to increase significantly.

Several OG projects focus on carbon sequestration and storage. Some examples are listed below, but more information is available in the comprehensive EIP-AGRI Operational Groups database[45].

The Italian "Stream Management to increase Carbon stock in Soil-SMACS" targets optimizing the use of wood biomass to increase the carbon stock of agricultural and forest soils.
The project "Accelerating the pathway to carbon zero farming by measuring and managing carbon flows" based in Northern Ireland focuses on producing an accurate individual net carbon position for the participating farms, using a whole farm carbon balance sheet to articulate the results of the precise measurement of the on-farm carbon stocks.

The Italian "Farm CO2Sink" project is intended to quantify the carbon sequestration potential at farm level and the reduction of GHG related to the adoption of a series of sustainable agricultural practices.

The French "Carbone 'N' Caux" explores and develops various sustainable farming techniques to achieve a positive carbon footprint. Along carbon sequestration, it strives to enhance the understanding of the interactions between carbon and nitrogen in the soil to improve input management, targeting a more autonomous system with optimized use of resources.

Over the past few years, the EIP-AGRI Network has furthermore organised several events related to climate change mitigation and carbon removals in the land sector. They included workshops, seminars, and dedicated Focus Groups on topics such as grazing for carbon, soil salinization, soil contamination, soil organic matter content in Mediterranean regions and nutrient recycling.

[44] https://ec.europa.eu/eip/agriculture/en
[45] https://ec.europa.eu/eip/agriculture/en/eip-agri-projects/projects/operational-groups