Carbon farming co-benefits

Approaches to enhance and safeguard biodiversity

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Abstract

Carbon farming standards promise to upscale much-needed on-farm climate mitigation. However, the carbon farming actions they incentivise will also impact biodiversity. We summarise carbon farming practices and their impact on biodiversity and review current carbon farming mechanisms to understand their approach to enhancing and safeguarding biodiversity, finding that most have insufficient protections to ensure net positive biodiversity impact. We identify the challenges and opportunities for implementing standards for biodiversity and conclude with requirements to ensure that carbon farming standards enhance and safeguard biodiversity, alongside delivering climate mitigation.

Contents

Abbreviations

AFOLU	Agriculture, Forestry and Other Land Use
CAP	Common Agricultural Policy
CO_2	Carbon dioxide
CRCM	Carbon Removal Certification Mechanism
EEA	European Environment Agency
EU	European Union
GHG	Greenhouse Gas
HNV	High Nature Value
IPCC	Intergovernmental Panel on Climate Change
LUCAS	Land Use and Land Cover
LULUCF	Land Use and Land Use Change and Forestry
$MtCO_2$-e	Metric tons of carbon dioxide equivalent
N	Nitrogen
N_2O	Nitrous Oxide
NRL	Nature Restoration Law
REDD+	Reduce Emissions from Deforestation in Developing Countries
SDGs	Sustainable Development Goals
SOC	Soil Organic Carbon
SOM	Soil Organic Matter
UNEP	United Nations Environment Programme
VCM	Voluntary Carbon Market

Executive summary

Carbon farming – the implementation of farm management practices to mitigate climate change – will need to play a key role for European Union (EU) to reach net zero GHG emissions. Within the EU, management of carbon pools, flows, and GHG fluxes through farm management practices offers an estimated emission reduction and carbon removal potential of 101-444Mt CO2-e per year.

The global loss of biodiversity is a parallel emergency to climate change – and agriculture is Europe's single largest contributor to biodiversity loss. Agricultural practices must change to reverse the current trend of EU-wide biodiversity loss. This will be essential to meet multiple EU policy targets, including those set by the EU Green Deal and the proposed EU Nature Restoration Law.

Carbon farming standards are increasingly seen as a solution to upscale carbon farming. The proliferation of private and public voluntary carbon market standards is reflected by the proposal of the Framework for Carbon Removals Certification by the EU Commission (November 2022), which seeks to ensure the high quality of carbon farming (and other types of) removals and thus trigger greater upscaling.

Overall, carbon farming standards pose both a risk and an opportunity for biodiversity. In this report we review ten carbon farming actions and standards and provide recommendations on how standards can safeguard and enhance biodiversity, as well as delivering climate mitigation.

Carbon farming practices and their impact on biodiversity

Carbon farming includes a range of agronomic practices, including land use changes as well as technological solutions. Carbon farming can be separated into five main categories of practices: Managing peatlands, agroforestry, maintaining and enhancing SOC on mineral soils, livestock and manure management, nutrient management.

These interventions can provide benefits for biodiversity: soil health benefits, above and below ground biodiversity, as well as other environmental co benefits such as water balance, air quality, and climate adaptation.

However, there must be careful consideration of the context-specific biodiversity impacts to avoid potential harmful impacts – a carbon farming practice that is beneficial in one area could in fact be harmful elsewhere: the original state, the type of ecosystem and the type of management are all factors to consider.

Overall, most carbon farming practices are expected to have no negative impact on biodiversity, but some practices involve risks (e.g. agroforestry on species-rich grassland, manure application).

Current approaches to safeguard and enhance biodiversity

Our review of ten carbon farming standards, methodologies, and policies identified five approaches to safeguard or enhance biodiversity, with different advantages and disadvantages:

- Define general sustainability requirements: e.g. obligation to obtain expert advice or consult advisory services, a commitment to "Do No Significant Harm", or a requirement to deliver multiple benefits (e.g. to Sustainable Development Goals).

- Set transparency requirements: e.g. publicly available project documents, stakeholder consultation.
- Define positive/negative lists: i.e. exclude the use of invasive species, recognise area specificities to protect or enhance biodiversity
- Obligation to monitor: qualitative and quantitative measurement of biodiversity impacts
- Make payments dependent on biodiversity outcomes as well as additional payments for biodiversity outcomes.

Overall, we conclude that none of the reviewed standards adequately promote biodiversity or safeguard against carbon farming having negative biodiversity impacts. The current carbon farming standards contain criteria or approaches to safeguard and enhance biodiversity to differing degrees. Some standards apply no biodiversity approaches; others apply several.

Opportunities and challenges

There is an opportunity to design EU wide carbon farming standards that **can enhance biodiversity while safeguarding against negative impacts**. For farmers, compensation for ecosystem conservation and restoration can provide an **incentive to adopt practices** that will benefit both climate and biodiversity. The integration of biodiversity into carbon farming standards presents an opportunity to establish an **EU-wide minimum standard for the monitoring of biodiversity co-benefits**.

However, the integration of biodiversity safeguards and enhancements presents challenges; **weighing the trade-offs** between climate and biodiversity objectives, as well as arbitrations between ecosystem services and species conservation objectives. The incorporation of biodiversity standards also presents **monitoring, reporting and verification challenges** for collecting data, defining baselines, selecting indicators as well as financing challenges.

Requirements for carbon standards to ensure net-positive biodiversity impacts

Carbon farming standards must do more to safeguard and enhance biodiversity through carbon farming actions. Failing to do so poses some significant risks, and misses a significant opportunity to maximise win-win outcomes for climate change mitigation and biodiversity.

We propose a targeted approach (see Figure 1 on page 18). This considers that different carbon farming actions pose different risks and opportunities for biodiversity. It also reflects that larger, more lucrative carbon farming projects and participants have larger impacts on biodiversity and are less likely to be deterred by more demanding biodiversity requirements (and their associated transaction costs).

1. Introduction

The 2022 IPCC report states that to reach global net zero greenhouse gas (GHG) emissions, emissions from some sectors will need to be compensated by carbon removals in the agricultural, forestry and other land use (AFOLU) sectors. Thus, AFOLU mitigation options can deliver large-scale GHG emission reductions and enhanced removals, although it cannot fully compensate for delayed action in other sectors (IPCC, 2022).

Carbon farming refers to the management of carbon pools, flows and GHG fluxes through farm management practices that aim to deliver climate mitigation in agriculture. Carbon farming practices include land-use changes as well as more technological solutions (McDonald et al., 2021). It has been estimated that the total additional EU carbon farming emission reduction and removal potential is of 101-444 Mt CO2-e per year (ibid).

The global loss of biodiversity is a parallel emergency to climate change. Biodiversity is defined as the variability among living organisms from all sources, including diversity within species, between species, and of ecosystems (UNEP, 2021). Biodiversity in the EU is in a continuous, strong decline (European Environment Agency, 2020). The largest contributor to biodiversity loss is agriculture including through conversion of natural ecosystems into agricultural land, intensification of management in long-established cultural landscapes, release of pollutants including greenhouse gases, and value chain impacts (Dudley & Alexander, 2017). Therefore, change is needed in the agricultural sector to reverse the current trend of biodiversity loss.

Carbon farming is being advocated for by public policies and private interests, particularly through the proliferation of voluntary carbon standards that incentivise carbon farming through voluntary carbon markets. These markets allow farmers to generate credits in return for implementing carbon farming actions; the credits can then be sold to voluntary buyers. Most of the global carbon standards focus on renewable energy and forestry, however with carbon farming methods emerging within Europe (Cevallos et al., 2019). While carbon farming standards' promise to bring in private funding for mitigation, they face many challenges, one of which is adequate consideration of biodiversity impacts (McDonald et al., 2021).[1]

This standard-based approach to carbon farming is also increasingly reflected in European policy. The European Commission's *Communication on Sustainable Carbon Cycles* at the end of 2021, outlining a plan to accelerate the upscaling of carbon farming practices into public support, as well as the *Proposal for a Regulation on an EU Certification for Carbon Removals* (November 2022). The approach fits alongside other EU support for carbon farming, including EU policies, such as the *Land Use and Land Use Change and* Forestry (LULUCF Regulation), which establishes an EU-wide net sink target for 2030, and the Farm to Fork Strategy, which emphasize the important role agriculture will play in meeting EU Green Deal targets for 2030 and beyond, as well as Member State Strategic Plans for 2023-2027 under the Common Agricultural Policy (CAP), which include measures for funding carbon farming practices.

The shift towards carbon farming practices can bring about rapid change in agriculture, which can provide both substantial opportunities for, and significant risks to, the protection and restoration of native ecosystems, with corresponding gains for biodiversity and reductions in atmospheric carbon. The EU's recently proposed Nature Restoration Law (NRL), which establishes targets to restore degraded land in the EU, emphasises that the restoration of degraded

[1] In addition to concerns about biodiversity impacts, a standards-based approach to carbon farming has been criticised due to concerns regarding impermanence of carbon removals, non-additionality, and the challenges of accurate and affordable quantification of mitigation impacts, among others.

ecosystems, particularly of habitats with a large potential to capture and store carbon, can contribute to both climate and biodiversity objectives, as well as preventing and reducing the impact of natural disasters. This provides an opportunity to 'maximise synergies' between climate mitigation and biodiversity conservation.

Ensuring that carbon farming can deliver biodiversity co-benefits is essential considering the dependence of agriculture on ecosystem services: components of biodiversity in agriculture and associated landscapes provide and maintain ecosystem services that are essential to the fertility and productivity of agricultural ecosystems. There are mutual and complex interactions between agriculture and biodiversity in which they are interdependent upon and can strengthen each other.

However, biodiversity could be disadvantaged if not properly accounted for, particularly where high carbon gains do not overlap with biodiversity priorities (Reside et al 2017). Such risks could include negative impacts on soil health, or risks to local biodiversity when implementing carbon farming measures if contextual and site considerations are not accounted for.

The objective of this report is to identify ways to ensure that carbon farming standards enhances and safeguards biodiversity. To do so, in section 2, this report provides an overview of carbon farming practices and their potential positive and negative impacts on biodiversity. In section 3, we review current carbon farming mechanisms to understand their approaches to enhancing and safeguarding biodiversity, and their strengths and weaknesses. Section 4 identifies the challenges and opportunities for implementing standards for biodiversity. Section 5 concludes the report with a proposal for requirements to ensure that carbon farming standards enhance and safeguard biodiversity, alongside delivering climate mitigation.

2. Carbon farming practices and their impact on biodiversity

Carbon farming includes a range of agronomic practices, including land use changes as well as technological solutions (McDonald et al., 2021). It should be noted that this report's definition of carbon farming is much broader than the definition provided by the European Commission in its *Communication on Carbon* Cycles, which focuses on carbon removals with potential avoided emissions also coming from peatland re-wetting. This report uses a bro

ader definition of carbon farming to include all GHG mitigation practices, a definition which goes beyond the European Commission's proposal for a Regulation on an EU certification for carbon removals.

Carbon farming can be separated into five main categories of practices, including:

- **Managing peatlands:** Peatlands are waterlogged land ecosystems that are typified by a high content of organic matter (i.e. stored carbon) and provide a variety of co-benefits, including biodiversity conservation, flood protection, water filtration, and others. Peatlands cover around 3% of EU-27 agricultural area. Yet drained peatlands emit around 25% of the annual agricultural emissions (Greifswald Mire Centre et al., 2019). Carbon farming applied to peatlands refers to three approaches: keeping existing peatlands wet, rewetting or restoring previously drained peatlands, or paludiculture, which describes the productive use of wetlands.

- **Agroforestry** is the practice of deliberately integrating woody vegetation (trees or shrubs) with crop and/or animal production systems on the same plot of land. Agroforestry covers approximately 8.8% of the EU's utilised agricultural area. Most existing systems in the EU are silvopastoral agroforestry systems, which typically combine animal grazing, foraging or fodder production with trees or other woody perennials on the pasture.
- **Maintaining and enhancing SOC on mineral soils** requires a positive balance of carbon inputs and carbon losses from soils. It is relevant to any farming system, and includes a wide range of carbon farming practices, including cover cropping, improved crop rotations, preventing conversion to arable land, conversion to grassland.
- **Livestock and manure management** refers to any actions taken by livestock farmers to reduce emissions from their farming operation. Actions include those aimed at directly reducing enteric methane, reducing nitrous oxide emissions through manure management, efficiency improvements including animal management to improve productivity, and animal fertility improvements.
- **Nutrient management** on croplands and grasslands focuses on activities that avoid N_2O emissions that result from the application of fertilisers and manure management. The focus is on reducing emissions from the use of synthetic fertilisers. Key strategies are improved nutrient planning and improving timing and application of fertilisers to avoid over fertilisation.

The mitigation potential and biodiversity impact of the above-listed carbon farming practices is provided in Table 1 below.

The next section provides an overview of the potential enhancement of biodiversity associated with these carbon farming practices, discussing co-benefits for biodiversity above and below ground, as well as the soil health benefits, and the potential risks to biodiversity. Other environmental co-benefits, such as water balance, air quality, and climate adaptation will also be discussed in this section.

There must be careful consideration of the biodiversity impacts in specific contexts to avoid potential harmful impacts – a carbon farming practice that is beneficial in one area could in fact be harmful elsewhere: the baseline situation of the site, the type of ecosystem and the type of management are factors to consider.

Soil health

A high level of soil organic carbon (SOC) is a key indicator for soil fertility and health, as soils with higher levels of SOC can store nutrients better and release them more slowly through mineralisation, and thus need fewer nitrogen or fertiliser inputs (Reise et al., 2022). Certain practices can reduce soil erosion and nutrient leaching, such as cover crops and crop rotation (Blanco-Canqui, 2018). Cover crops decrease runoff and sediment loss and may reduce the use of herbicide applications to suppress weeds (ibid). Crop rotation has been shown to increase soil multifunctionality, bacterial species richness and community composition (Li et al., 2021), significantly increasing pest and disease control and soil quality (Beillouin et al., 2021) and can provide higher microbial abundance, supporting soil health and fertility (Tiemann et al., 2015). Both cover crops and crop rotation are associated with higher yields as a result of the positive impacts on soil health (Agomoh et al., 2021).

Agroforestry systems, including silvopasture and silvoarable systems, also demonstrate positive effects on erosion control and reduce nutrient leaching by improving soil cover, since soils are protected from erosion by wind and water by the presence of trees (Drexler et al., 2021;

Kay et al., 2019; Torralba et al., 2016). Up to 65% reduction in erosion and 28% reduction in nitrogen leaching has been observed for soils with the adoption of silvoarable agroforestry systems, compared to arable land without trees (Palma et al., 2007). Agroforestry systems also improve soil quality and health by improving the availability of soil nutrients, and enhancing soil microbial dynamics (Dollinger & Jose, 2018). Planting trees near intensive cattle and pig farms can significantly reduce nitrogen deposition on semi-natural habitats (Bealey et al., 2014).

Peatland re-wetting also contributes to the retention of nutrients that are mobilised in degraded peatland through decomposition and peat soil degradation (Bonn et al., 2016; Steffenhagen et al., 2008).

Improved nutrient and manure management on croplands and grasslands can limit some of the negative impacts on soil health caused by the use of synthetic inputs such as mineral fertilisers, if the change in management results in a decrease in net nutrient inputs and reduced nutrient loss. The excessive use of mineral fertilisers has negatively impacted the functioning of many productive soils (Krasilnikov et al., 2022). An imbalanced use of chemical synthetic fertilisers can alter soil pH, acidification, and soil crust, which results in a decrease in SOC and useful organisms, stunting plant growth and yield (Ozlu & Kumar, 2018; Pahalvi et al., 2021). The integration of legume crops in the rotation can reduce the use of N-fertilisers, while the nitrogen-fixing potential of legume crops can increase the N supply in soil by 36-49% (ibid). Animal manure application is also correlated with positive soil health impacts compared to soil treated with mineral fertiliser: increased soil organic matter and a lower soil bulk density that supports the growth of crop roots (Rayne & Aula, 2020).

However, soil health benefits are dependent on the timing of the application and the amount that is applied, and therefore must be carefully managed. Ill-managed and poorly timed applications that result in higher nutrient inputs or increased pollution will have negative impacts on biodiversity. Manure applications can cause pollution through run-off into water courses or groundwater and through ammonia emissions. Manure from intensive conventional farming contains high levels of nitrogen and phosphorus from substantial use of animal food supplements and antibiotics, potentially jeopardizing the ecosystem once applied to soils (Köninger et al., 2021). Monitoring of Natura sites in Ireland found ammonia concentrations ranging from 0.47 to 4.59 μg NH_3 m^{-3}, a level significantly higher than can be tolerated by nitrogen-sensitive habitats such as bogs, heathland or many semi-natural grasslands, and that is resulting in degradation of the biodiversity value of these EU protected habitats (Kelleghan et al., 2021). The ammonia emissions are mainly from the manure or slurry applications of intensive dairy farms in the surrounding countryside. In intensively farmed regions such as Flanders (Belgium), any increase in manure applications onto farmland will increase the already high negative impacts of ammonia on biodiversity, which are already in exceedance of the critical load for sensitive Annex I habitats (de Pue & Buysse, 2020).

Likewise, nutrient management on croplands may involve risks for biodiversity. The use of nitrification inhibitors may increase the risk of ammonia release. Ammonia and nitrous oxide emissions from fertiliser use have adverse impacts on ecosystem biodiversity through deposition and increased N loading in sensitive sites (Erisman et al., 2011; Zaman & Nguyen, 2012) (Erisman et al., 2011).

Biodiversity above ground

Peatland re-wetting and agroforestry can provide food, shelter, habitat and other resources for multiple species both rare and specialised (Reise et al., 2022), such as pollinators (Bonn et al., 2016), birds (ibid), invertebrates (Paracchini et al., 2008), and in the case of peatlands the recovery of aquatic macro-invertebrate fauna (Artz et al., 2018). The rotation of crops to enhance soil organic carbon can also improve on farm biodiversity and landscape-level in space and time, increasing habitat niches for wildlife biodiversity.

Peatland re-wetting is associated with increasing populations of numerous species listed in Annex I of the Birds Directive within just a short number of years (Joosten et al., 2014). Peatlands can also provide support for species from other habitats, by providing permanent or temporary refuges for relict plant species and for species at the edges of their ranges, which have been displaced from their original habitats (Bonn et al., 2016). Research has also found that rewetting peatlands are colonised by assemblages of aquatic organisms that are similar to previously undisturbed peatland sites (Brown et al., 2016; Carter et al., 2015; Swindles et al., 2016).

The stocking rate of livestock can have a significant impact on plant diversity. Livestock management practices involving light or moderate levels of grazing usually result in greater plant diversity than either grazing exclusion or heavy grazing (Schieltz & Rubenstein, 2016; Watkinson & Ormerod, 2001). Nevertheless, it should be noted that the overall net effects of livestock grazing on biodiversity are highly context dependent. Fully rewetted peat soils can be grazed at a very low density by water buffalo but can only be grazed by cattle for short periods when the groundwater table temporarily drops below the surface.

Agroforestry can enhance tree structures across croplands, which can support biodiversity-friendly landscapes by achieving a large-scale mosaic of more natural habitat (Tscharntke et al., 2021), promoting ecosystem stability by providing more suitable habitat for species (Harvey & González Villalobos, 2006). Traditional agroforestry areas on the Iberian Peninsula, known as dehesa or montado, and grazed or mown tree pastures in Scandinavia are protected under the EU Habitats Directive and are frequently recorded as High Nature Value (HNV) farmlands (Paracchini et al., 2008). Agroforestry systems demonstrate a strong positive effect on bird community diversity, by encouraging birds normally associated with hedgerow and woodland onto grassland or cropland, while also supporting more invertebrate food for birds (ibid).

However, there are risks associated with establishing new agroforestry systems on land that already has a high biodiversity value. Introducing agroforestry in semi-natural grasslands is likely to harm biodiversity since such Annex I grasslands are among the most species-rich habitats in Europe, and tree planting will significantly damage the grassland (Reise et al., 2022). Intensive agroforestry systems, in particular monocultures such as poplar plantations, are poor quality habitats and lead to an overall loss of ecosystem services compared to mixed farmland, only providing some value in very intensive arable dominated landscapes (Jarrett, 2022). Introducing trees into traditional low intensity arable landscapes, known as pseudo steppes, negatively affects those bird species that are adapted to such open landscapes, including many of the threatened bird species in the EU.

Biodiversity below ground

Soil organic carbon is a major driver of below ground biodiversity, providing a source of energy and food for microorganisms that are essential to the biological process in the soil, which in turn contributes to the formation of soil organic matter through decomposition and the production of humus (Laban et al., 2018). These interactions create multiple reinforcing feedback loops: soils with high organic matter are capable of supporting greater vegetation diversity, which in turn increases SOM and SOC, while enhancing below ground biodiversity (Bernoux & Chevallier, 2014). Studies have demonstrated that even marginal reductions in SOC content can have a significant negative impact on below-ground biodiversity (Brady et al., 2015).

Research has found that microbial recovery upon re-wetting of peatlands is substantial, which is of great consequence for below ground biodiversity since by controlling nutrient cycling, and greenhouse gas emission and uptake, microbial communities are among the primary drivers of eco-system functioning (Tanneberger et al., 2021). However, this recovery and its associated benefits are conditional on the level of degradation of the drained peat soil and may not deliver the same level of biodiversity as preserved peatlands (Lamers et al., 2015; Renou-Wilson et al., 2019). Agroforestry alley-cropping systems introduce tree row-associated bacteria which alters soil bacteria composition and increases the overall microbial diversity of arable land (Beule et al., 2021).

The application of high-quality manure on agricultural soil can also promote below-ground biodiversity. Manure can stimulate soil microbial and fungal activity in relation to inputs of organic carbon, nutrients, and microorganisms, and increase the abundance and biomass of soil fauna (Liang et al., 2013; Watts et al., 2010). The presence of livestock manure that has not been treated with veterinary medicines is essential for the maintenance of the diverse community of invertebrates that feed on dung pats on permanent grassland, and their associated predators and other species, notably bats and birds. However, manure that contains antibiotics or anthelmintics has a significant negative effect (Hammer et al., 2016; Wall & Beynon, 2012).

There are potential risks related to the application of biochar. A meta-analysis of 194 studies reveals that this practice may increase microbial biomass, but negatively impact microbial diversity, especially for biochars produced under high temperature (Wang et al., 2020). Fungal and bacterial diversity are potentially decreased by biochar application in alkaline and fine-textured soils.

Other co-benefits

Water balance

Many carbon farming practices have been linked to improved resilience to water stress.

The physical properties of peat enable it to retain and store mass amounts of water dozens of times that of its structural matrix (Bonn et al., 2016). Vegetation and peat influence hydrology through their effect on surface flow, groundwater, and evapotranspiration, constituting strong feedback effects between plants, peat, and water (ibid). Even though degraded peatlands, once re-wetted, are not able to store as much water as to those that remained intact due to low peat thickness and porosity, they still positively affect water balance and act as a flood protection (Artz et al., 2018; B. Liu et al., 2022), as well as supporting generations of living organisms through even the longest periods of normal drought for the prevailing climate (Bonn et al., 2016). Agroforestry can also improve water conservation and soil water storage (Torralba et al., 2016), using available water more efficiently because agroforestry systems occupy more ecological niches (Reise et al., 2022). Compared to annual crop systems, agroforestry also reduces surface runoff and evaporation (ibid). Soils with higher soil organic carbon levels increase soil water capacities both directly and indirectly through soil structure and aggregate stability, resulting in increased pore size and volume (Gollany et al., 2010). Soil quality improvements from SOC result in increased movement of water through soil and available water capacity (ibid). Manure management practices also demonstrate having a positive water holding capacity of the soil due to increased SOM aggregation of soil particles (Rayne & Aula, 2020).

Climate adaptation

The water balance co-benefits have implications for adaptation to climate change, in which the increased frequency severe weather events such as of floods, droughts, and wildfires are expected. Revegetation of peatlands can slow the flow of water during storm events to reduce the flood peak downstream (Artz et al., 2018; Shuttleworth et al., 2019). These effects can be proportionally greater even for the largest storm events (Gao et al., 2018). Wet peatlands also have a lower fuel load, and wetter conditions act to reduce the chance and severity of wildfires.

Trees planted through agroforestry practices can provide shade to plants and by improving water storage can allow soils to withdraw a large amount of water, facilitating the growth and production of food crops even during long lasting droughts (Udawatta et al., 2021). Soil modification processes linked to agroforestry can also contribute to the reduction of floods (ibid). Introducing agroforestry on grazing lands contributes to adaptation similar to agroforestry on croplands, buffering weather extremes but also providing a cooler environment for livestock, as well as reducing damage from droughts (Torralba et al., 2016).

The adoption of soil nutrient management practices, such as soil testing and formulated fertilisation, can positively impact farmers’ ability to absorb and recover from climate-related shocks and stresses (Q. Liu et al., 2022).

Table 1: Overview of carbon farming practices, their estimated mitigation potential and biodiversity impacts (based on McDonald et al. 2021, own elaboration)

Assessment criterion	Mitigation potential (Mt CO_2-e/yr)	Carbon farming actions	Biodiversity impacts		
			Soil health	Biodiversity above ground	Biodiversity below ground
Managing peatlands	51-54	Peatland rewetting, maintenance, management, paludiculture		**Co-benefit:** Improved site-specific biodiversity, particularly aquatic organisms	**Co-benefit:** Microbial recovery
Agroforestry	8-235	Creation, restoration, and management of woody features in the landscape	**Co-benefit:** Improved soil health; increased disease and pest control	**Co-benefit:** Improved biodiversity and microclimate, especially for bird communities **Risk:** Negative impacts if planted on high biodiversity grassland or in pseudo steppe arable areas	**Co-benefit:** Increase in overall microbial diversity of croplands **Risk:** Intensification of agroforestry systems (especially monocultures) may lead to a loss of ecosystem services
Maintain and enhance soil organic carbon on mineral soils	9-70	Cropland and grassland management (permanent and ley)	**Co-benefit:** Improved soil health; positive impacts on erosion control and reducing nutrient leaching	**Co-benefit:** Improved biodiversity, with increased habitat niches for wildlife	**Co-benefit:** Improved soil structure and soil fertility capable of supporting greater vegetation diversity **Risk:** Biochar may negatively impact microbial and fungal diversity
Livestock and manure management	14-66	Technologies to reduce enteric methane, manure management, increased herd and feed efficiency	**Co-benefit:** Decreased nutrition runoff; higher SOM and lower soil bulk density	**Co-benefit:** Reduced grazing intensity can lead to greater plant diversity; Organic/veterinary chemical-free manure essential for dung-dependent biodiversity **Risk:** Increased ammonia emissions can significantly increase already existing negative impacts on sensitive habitats and species	**Co-benefit:** Increased abundance and biomass of soil fauna **Risk:** Manure application may raise pollution risks from use of animal food supplements, potentially jeopardising the ecosystem once applied to soils
Nutrient management on croplands and grasslands	19	Improved nutrient planning, timing, and application of fertilisers; reduction in fertilisers	**Co-benefit:** Decreased nutrition runoff; reduces pest attacks, acidification, and soil crust	**Co-benefit:** Reduced nitrogen emissions will reduce pressures on sensitive habitats and species **Risk:** May increase the risk of ammonia release	**Co-benefit:** Reduced negative impacts of toxicity to organisms associated with excessive fertiliser use **Risk:** May negatively impact ecosystem biodiversity through deposition and increased N loading in sensitive sites

3. Current approaches to safeguard and enhance biodiversity

Methodology

To understand how biodiversity co-benefits are promoted and sustainability safeguarded, we evaluated ten carbon farming standards and policies (which we refer to collectively as mechanisms). Carbon farming standards consist of methodologies for carbon farming mitigation and reward mechanisms; they set out how carbon farming should be implemented, quantified, and verified, and how this will be rewarded (for example, through voluntary carbon markets). Carbon farming policies establish incentives for carbon farming, and also set eligibility and implementation rules, which can include sustainability requirements.

We selected standards, methodologies and policies that cover the range of carbon-farming actions including soil carbon storage and sequestration, agroforestry, management of peatlands, livestock and manure management. Nutrient management on cropland and grassland was not considered as a carbon farming action in this analysis due to missing mechanisms addressing the issue. We also reviewed a number of more general, cross-cutting EU and international sustainability standards and policies. More information on the selected carbon farming mechanisms and the result of the screening can be found in the Annex, which is summarised in table 2.

Our screening of the mechanisms identified five approaches to safeguard or promote biodiversity co-benefits, which are introduced below Table 2. Overall, most of the identified mechanisms include one or several approaches to safeguard or enhance biodiversity co-benefits. General sustainability requirements and transparency requirements as a minimum standard are not always included. Approaches to monitor biodiversity impacts vary greatly between the mechanisms screened. None of the selected carbon farming mechanisms offer comprehensive and sufficient approaches to enhance biodiversity through their methodology.

Table 2: Approaches to safeguard or enhance biodiversity in carbon farming mechanisms

Mechanisms			Approach to biodiversity co-benefits				
Name	Type	Climate action	General sustainability requirements	Transparency requirements	Positive-/ negative lists	Monitoring	Multiple payments
Australian Emission Reduction Fund (ERF)	Public VCM	Soil organic carbon					
CarbonAgri (Label Bas Carbone)	Public VCM	Livestock and manure management	x	x		x	x
Gold Standard Soil Organic Carbon Framework	Private VCM	Soil organic carbon	x	x	x	x	
IFC – Social and Environmental Performance Standard 6 Biodiversity Conservation	Private investment criteria	General	x	x	x	x	
MoorFutures (Version 2.0)	Private VCM	Managing peatlands	x	x		x	x
Nori – Cropland methodology	Private VCM	Soil organic carbon					
Verra – Jurisdictional Nested REDD	Private VCM	Forest and soil organic carbon		x			
Verra – VCS Indigo Ag methodology for improved agricultural land management	Private VCM	Soil organic carbon	x		x	x	
EU Common Agricultural Policy (CAP)	Public funding	General	x	x	x		x
EU Sustainable Finance Taxonomy (Technical expert group proposal)	Public investment criteria	General	x		x	x	

VCM = Voluntary carbon market

Approaches to biodiversity co-benefits

General sustainability requirements

Our review identified that seven of the ten mechanisms we assessed seek to protect and enhance biodiversity by setting minimum requirements which aim to ensure that carbon farming actions either have no negative impact and/or have net positive impact on other sustainability objectives. Examples of this approach include a mandatory **advisory service,** that helps farmers to better understand and meet the EU rules for the environment and good agricultural and environmental condition or a "**Do No Significant Harm**" (DNSH) requirement, where carbon farming actions can only receive incentive payments if they are expected not to negatively impact other sustainability indicators, including biodiversity. Alternatively, some mechanisms require carbon farming actions to generate **multiple benefits** (i.e. to meet at least one more sustainability objective besides climate mitigation), for example using the Sustainable Development Goals (**SDGs**) as a framework. However, this requirement does not necessarily include a biodiversity objective.

Strength/weaknesses: These general sustainability requirements lack specific protections for biodiversity, or may only require some general procedure that is designed to safeguard that no significant negative impact occurs. This is a relatively weak requirement that is highly reliant on the quality and effectiveness of the advice received or of the DNSH analysis. In addition, while they provide a framework, they often require additional approaches (from the list below) to be implemented. On the other hand, site-specific and well-informed advice or DNSH analysis can be highly effective at avoiding negative impacts and incentivising positive actions.

Transparency requirements

Mechanisms can also encourage biodiversity co-benefits by setting a **transparency requirement**. This includes making project documents publicly available, including verification and validation reports, especially any information on biodiversity impacts. This also includes mandatory **stakeholder consultation and engagement**, in methodology development, and during the entire term of the project (for example, by establishing processes to involve stakeholders in verification and validation, and stakeholder complaint processes).

Strengths/weaknesses: Transparency and positive stakeholder involvement can increase trust and accordingly consumer willingness to pay for biodiversity-positive projects, but will only effectively achieve net biodiversity gain through the involvement of biodiversity-literate stakeholders. The effectiveness of transparency requirements depends on other approaches listed above, e.g. requiring reliable monitoring of biodiversity impacts. Stakeholder involvement can be time consuming, while transparency requirements don't always live up to the ambition to be fully transparent.

Positive/Negative lists

Mechanisms can exclude actions that pose biodiversity risks using **negative lists**, which exclude actions, areas, or actors from funding if they are seen to carry risks for biodiversity. Alternatively, they can promote actions that have positive impacts on biodiversity by only funding actions on a **positive list**. For example, they may exclude the use of invasive species or only fund actions using native species. A related requirement is the requirement to **recognise area specificities** to protect or enhance biodiversity, e.g. excluding funding for areas that have been recently deforested or neighbour high biodiversity areas that could be negatively impacted.

Strengths/weaknesses: Positive-/negative lists are generally low cost and easily implemented, and therefore relatively effective. However, one-size-fits-all positive-/negative lists will generally not cover all possible contexts and may be too restrictive in some contexts whilst allowing too many potentially damaging actions in other contexts. They may need some flexibility to be adapted to local contexts, which requires site-specific inputs by experts.

Monitoring

Six of the ten examined mechanisms require some degree of monitoring or assessment of biodiversity impacts. These include **qualitative approaches**, such as a benefits matrix (where projects have to report qualitative scores for impacts on sustainability objectives (e.g. from 1-5). Some require **quantitative approaches**, with monitoring of biodiversity impacts, for example using indicators, modelling, or in-situ soil biodiversity measurements. A combined approach is also applied, such as a requirement to carry out an impact assessment and develop a monitoring program using relevant biodiversity indicators.

Strengths/weaknesses: Monitoring of biodiversity impacts is essential to verify whether the standard achieves biodiversity co-benefits and avoids significant harm to biodiversity. Monitoring also focuses attention on the co-benefit and provides information that can allow for adaptation and progress towards a certain, positive impact on biodiversity that goes beyond climate mitigation. Qualitative approaches can have low accuracy while quantitative approaches potentially have high monitoring, reporting, and verification (MRV) costs.

Multiple payments

Three of the ten examined mechanisms make the payment dependent on both climate mitigation outcomes and biodiversity outcomes. These can be direct **result-based payments** tied to biodiversity outcomes, building on monitoring (often quantitative). Positive biodiversity outcomes can also be encouraged through **indirect incentives**, such as where biodiversity outcomes are listed on carbon credits, increasing consumers' willingness to pay.

Strengths/weaknesses: Direct payments for biodiversity outcomes are a strong, clear incentive for farmers. Funders also benefit from being able to directly or indirectly fund actions that they prefer (i.e. that deliver biodiversity as well as climate benefits). However, these approaches may have higher MRV costs due to monitoring requirements (see monitoring) and increase complexity for buyers and sellers.

4. Opportunities and challenges of carbon farming co-benefits

Carbon farming standards that work for both climate change mitigation and enhancing or safeguarding biodiversity must sufficiently address both objectives. This section highlights the main opportunities associated with the inclusion of approaches to biodiversity, as well as discussing the challenges associated with including safeguards and enhancements for biodiversity in a carbon removal certification mechanism. This discussion aims to better understand how such an inclusion will need to be designed in order to ensure positive environmental outcomes.

Opportunities

As discussed in the introduction, the inclusion of biodiversity co-benefits into carbon farming standards addresses the synergies between climate and biodiversity action. While there is recognition that biodiversity restoration and climate change mitigation and adaptation are inextricably linked, in practice they are largely addressed by separate policy domains. This functional separation creates a risk of incompletely dealing with the connections between the two and may lead to actions that inadvertently prevent the solution of one or the other, or both, and fails to generate any synergies. Therefore, the integration of biodiversity safeguards in carbon farming standards create an opportunity to design standards that can yield biodiversity benefits while minimising risks.

For farmers, the inclusion of biodiversity co-benefits in a carbon removal certification mechanism presents the opportunity to get a higher payment for the adoption of practices that have both climate and biodiversity benefits. Even if farmers choose not to integrate practices that benefit biodiversity, the design of a certification mechanism could also facilitate funding that would still benefit biodiversity. For example, if a carbon farming project does not have a net-positive impact, then part of the money from the carbon removal certificate could be allocated to a biodiversity conservation fund.

In the voluntary market, the availability of joint carbon and biodiversity credits can be expected to stimulate increased participation by commercial companies, who may value the opportunity to distinguish themselves from competitors in terms of their environmental credentials. The success of the MoorFutures scheme indicates that there is a strong interest from business in joint carbon and biodiversity credits.

Voluntary private sector investment can make a significant contribution for companies to achieve positive outcomes for nature through their investments. However, policy frameworks to facilitate such investments are not in place. Including standards for biodiversity in a voluntary carbon market can provide such a framework.

Monitoring is a crucial tool for measuring the progress and success of policies and management programmes. The EU carbon removal certification could set an EU-wide minimum standard for monitoring biodiversity co-benefits.

Challenges

The main objective for integrating biodiversity co-benefits into a carbon removal certification mechanism is to design an approach that will *both* translate into positive impacts on the climate and maximise the potential for nature restoration. This is challenging in light of the potential for biodiversity trade-offs as well as the problem of ecological traps.

Trade-offs between ecosystem services exist. For example, grazing practices with low stocking rates can restore above ground species biodiversity on grasslands, but moderate to high stocking rates may have negative impacts on soil erosion, which in turn can negatively impact water quality (Martino et al., 2022). There are also trade-offs between actions that benefit different kinds of species, and may require decisions to be made as to which species should be prioritised. For example, planting trees on open farmland increases overall bird species richness but can have a deterrent effect on specialist bird species that require open landscapes.

Ecological traps refer to a situation in which a species may be attracted to a site but the site conditions do not allow for successful reproduction - it becomes a sink for breeding adults. If the breeding adults move into the site from an area where they were reproducing successfully, the species is said to be caught in an 'ecological trap" (Joosten et al., 2014, p.87). Therefore, management options will need to be developed to help avoid such traps, or minimise their effects (ibid).

In addition to these trade-offs, designing a mechanism that can address the problems associated with monitoring, reporting, and verification (MRV) for both carbon removals and biodiversity will be particularly challenging.

Challenges for ensuring beneficial biodiversity outcomes

Biodiversity monitoring requires sound data collection over large temporal and spatial scales. This is because biodiversity impact metrics should be able to report linked trends in specific human activities and changes in biodiversity state, accounting for both the ecology of different species and the cumulative effects of historical habitat losses. Biodiversity monitoring requires surveillance activities carried out regularly over long periods of time, which can be costly.

Biodiversity monitoring requires the identification of a baseline value for biodiversity, to measure change in biodiversity over time, to define targets for biodiversity conservation and to evaluate conservation progress. The lack of sufficient available biodiversity information to set baselines is widely recognized as a major barrier.

Indicators are necessary for the quantifiable assessment and comparison of biodiversity, as it is not possible to measure everything. Biodiversity indicators can measure the status of species, habitats, or functional diversity of ecosystems, in space and time, such as the number of species, relative abundance of species, or area of intact habitat.

By definition, biodiversity incorporates not only differences between species but within species themselves and of the environments and ecosystems where they are found and most species indicators do not capture this complexity. Indicators based on species diversity or abundance of common species do not capture the value of rare and endemic species, or the presence of undesirable species that negatively affect ecosystem health. It is therefore useful to include a basket of biodiversity indicators that capture more contextual factors such as regional characteristics, habitats, rare species, and different scales.

However, trying to reflect the multidimensionality and complexity of biodiversity can be costly and difficult. The EU biodiversity data landscape is currently highly fragmented, with Member States using a variety of methods for data collection, making it difficult to compare information. Biological records can be highly variable in their level of accuracy and completeness. Data collected in an unstandardised way requires methods that correct for the biases in the data. Variability in methods for measuring an indicator can create challenges to ensuring consistency and comparability of standards or credits at the national, regional and global level.

There are currently no EU wide indicators for measuring soil biodiversity and functions, but the recently established European Soil Observatory, and the soil biodiversity module of the LUCAS soil survey is developing an EU soil biodiversity monitoring system. However, although research efforts are increasing, a more complete understanding of biodiversity in soils is needed (Geisen et al., 2019). In addition, soil monitoring is costly and therefore decisions will need to be made on what scale this will occur.

5. Requirements for carbon standards to ensure net-positive biodiversity impacts

Carbon farming has the potential to change agriculture in Europe. Shifting public funding and the fast growth in carbon farming mechanisms provide new incentives for farmers to mitigate climate change on farm, which should result in significant farm management and land use changes – and a real contribution to fighting climate change.

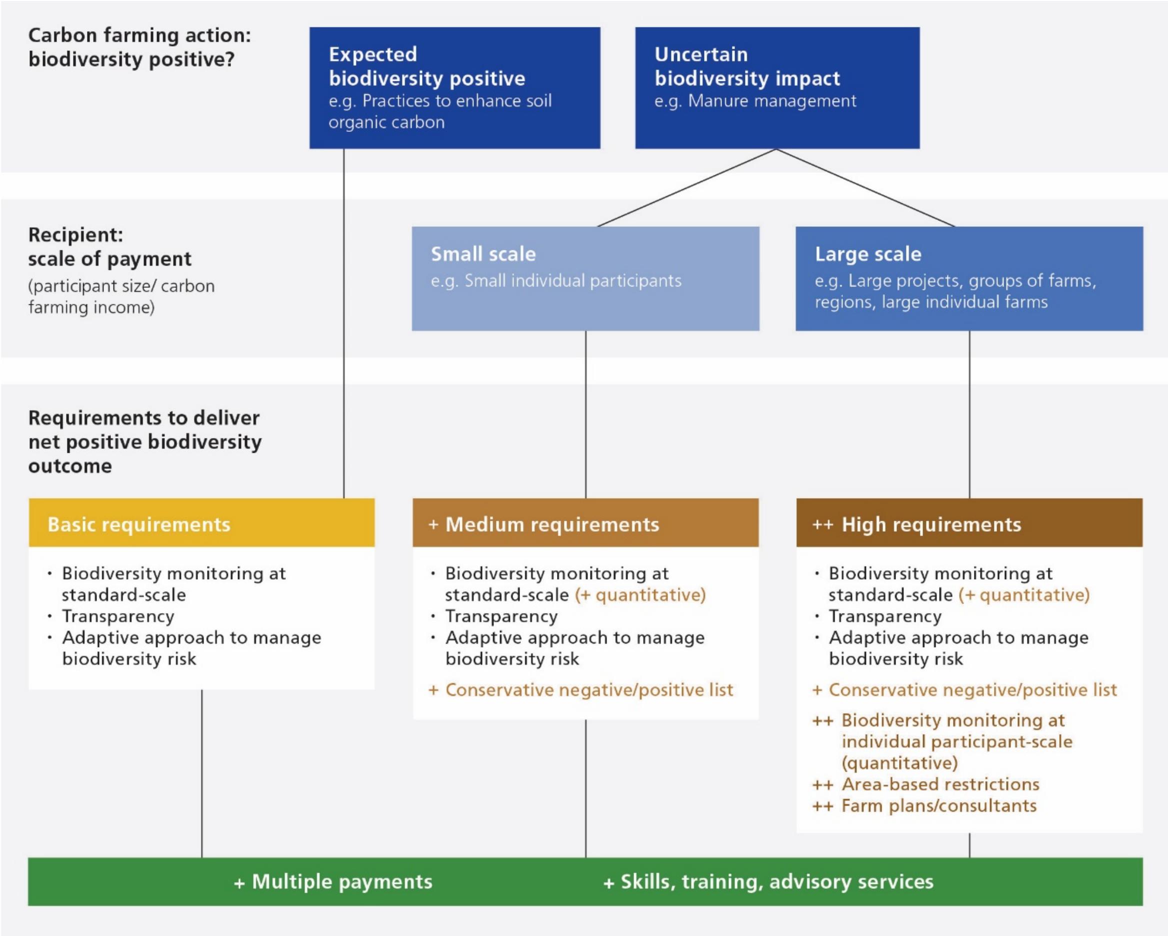
These changes pose risks and opportunities for confronting the global biodiversity crisis. It is essential that farming reverse its history of driving biodiversity loss. Carbon farming must be funded only if the actions also deliver biodiversity benefits – that is, carbon farming must deliver overall net-positives for biodiversity.

The growth in carbon farming standards – as illustrated by the EU Commission Carbon Removal Certification Regulatory Framework - poses a particular risk and opportunity for biodiversity. Our assessment of ten carbon farming standards has shown that none of them include all the approaches and requirements that are necessary to prevent negative effects on biodiversity and ensure net positive gain of biodiversity objectives.

Drawing on our evaluation of ten existing carbon farming standard approaches to safeguard and promote biodiversity (see table 2), we propose a differentiated approach to safeguarding and enhancing biodiversity in carbon farming standards (see figure 1). This takes into account two key factors:

1) **Uncertainty in biodiversity impact - Different carbon farming actions have different expected impacts on biodiversity: carbon farming actions that may have uncertain biodiversity impacts should be more carefully managed.** Nevertheless, even standards that promote carbon farming actions that are expected to have positive biodiversity impacts should have some basic minimum requirements. These should include monitoring of biodiversity impacts at the standard-scale, transparency, and an adaptive approach to monitoring results.
2) **Scale of project – Small or large - Larger, more lucrative carbon farming projects and participants will have larger impacts on biodiversity, will not be deterred by higher biodiversity requirements, and should therefore face more stringent requirements.** Protecting and enhancing biodiversity can be costly for farmers and carbon project developers. Low-cost, conservative measures (such as positive/negative lists) can help ensure that carbon farming actions are biodiversity positive and can be implemented in smaller projects at relatively low cost, without acting as a barrier to farmer participation. More accurate, targeted (and expensive) approaches such as participant-scale monitoring are appropriate for larger, grouped, or more profitable carbon farming actions.

Figure 1: Recommended approach to enhance biodiversity through carbon farming funding



Basic requirements would apply to those carbon farming actions expected to be biodiversity positive, these would include some monitoring at the standard-scale. This standard-scale monitoring could monitor unexpected negative biodiversity impacts and identify best-practice approaches to maximise co-benefits. This must be accompanied by transparency requirements in making project documents publicly available, especially any information on biodiversity impacts including stakeholder consultation and involvement, and an adaptive approach where the standard responds to monitoring data.

Medium requirements would apply to carbon farming actions where there is some uncertainty whether the action will be biodiversity positive and where the scale of carbon farming payment is small. This would include the basic standard plus positive or negative lists that mean only low-risk carbon farming projects are eligible. For example, positive lists could limit funding to actions using native species and negative lists could exclude actions near nature reserves. In addition, quantitative standard-scale monitoring should be in place.

High requirements would be applied to larger scale carbon farming actions with uncertain biodiversity impacts. Large scale projects pose greater risks to (or offer greater opportunities to enhance) biodiversity so should be matched by more stringent requirements beyond the medium standard. This should include robust biodiversity monitoring for each funding recipient. To reduce costs, biodiversity indicators should be captured alongside carbon farming data collection. This could include soil biodiversity, biotope value or indicators on species level. Biodiversity management should take into account the individual context of the beneficiary, with area-based targeting. Farm consultants and creation of farm sustainability plans can help maximise biodiversity co-benefits.

Alongside these standards, the use of multiple-payments (with financial incentives for biodiversity outcomes alongside carbon outcomes) and farmer upskilling and support will be essential to maximise the biodiversity benefits of carbon farming. Multiple payments should provide payments for additional biodiversity provision. This may require more robust individual monitoring that goes beyond the “basic requirements”.

In this report, we have focused on biodiversity recommendations to carbon farming standards due to the emergence of carbon-crediting schemes and their promotion through EU policy, as illustrated by the Proposal for a Regulation on an EU Certification for Carbon Removals. Safeguarding and enhancing biodiversity must not only be a fundamental part of the regulatory framework for carbon removals, but also work for carbon farming actions in general. This requires a more holistic, integrative approach to land management that considers both climate mitigation and biodiversity in synergy, and also the delivery of further sustainability objectives such as water balance, air quality and climate change adaptation.

Annex

Australian Emission Reduction Fund (ERF)

Introduction			
The Australian ERF is a carbon credit system to avoid the release of GHG emissions or sequester carbon from the atmosphere in Australia. The agricultural methods include i.a. beef cattle herd management, estimation of SOC sequestration using measurement and model-based approaches and improved nutrition management. In addition to carbon abatement, beneficiaries may (but are not obliged to) achieve other economic, social, cultural and environmental benefits including enhanced biodiversity.			
Type	Public VCM	**Climate action**	Soil organic carbon
Approach to biodiversity co-benefits			
General sustainability requirement	None		
Transparency requirements	None		
Positive-/negative lists	None		
Monitoring	None		
Multiple Payments	None		
Source			
Australian Government (2022). Clean Energy Regulator. Purchasing ACCUs with co-benefits. Accessed 12.10.2022 https://www.cleanenergyregulator.gov.au/Infohub/Markets/buying-accus/purchasing-accus-with-co-benefits			

CarbonAgri (Label Bas Carbone)

Introduction			
Carbon Agri is a methodology for voluntary carbon removal projects in the agricultural sector, developed by the French government's Label Bas Carbone. It provides a method for project developer to account for emissions reductions and some carbon sequestration on cattle farms in France. These validated emissions reductions can then be traded for payment from an external party voluntarily offsetting their emissions. The method includes six types of actions: herd management and feeding, animal manure management, crop & grassland management, consumption of fertilisers, and energy, and carbon storage (in total 40 low carbon practices). It quantifies both reductions on farm as well as associated upstream emissions, applying life cycle assessment.			
Type	Public VCM	**Climate action**	Livestock and manure management
Approach to biodiversity co-benefits			

General sustainability requirements	**Advisory service:** A consultant is involved to set the baseline and to measure again at the end of the project period. Advisory to the farmers are part of the process.
Transparency require-ments	**Transparency:** Biodiversity impacts reported at standard-scale (i.e. all 300+ farmers applying the CarbonAgri standard); they report biodiversity increase of 2%.
Positive-/negative lists	**None**
Monitoring	**Quantitative approach:** The mitigation measurement tool CAP2er calculates climate mitigation and other environmental impacts, including biodiversity. This is reported using an indicator "increased biodiversity contribution", which is re-ported as ha equivalent of biodiversity. **Monitoring**: Monitoring and reporting at the beginning and the end of a project (i.e. t=0 and t=5).
Multiple Payments	**Biodiversity results-based payment:** ha biodiversity equivalent (calculated by CAP2er farm carbon audit tool)
Source	
French Ministry of Ecological Transition (2019) CARBON AGRI - Méthode de suivi des réductions d'émis-sions en élevages bovins et de grandes cultures conforme au Label Bas Carbone (2019). Link: https://www.ecologie.gouv.fr/sites/default/files/M%C3%A9thode%20%C3%A9levages%20bo-vins%20et%20grandes%20cultures%20%28Carbon%20Agri%29.pdf	

Gold Standard Soil Organic Carbon Framework

Introduction			
Gold Standard is a not-for-profit organization established by WWF and other international NGOs to certify and provide a mechanism for voluntary offsetting by emission reductions/removals. Gold Standard offers methodologies for many sectors, though the majority of credits produced come from avoided emissions through renewable energy (42%), with only small amounts from forestry (2%) or agriculture (0.2%). The Soil Organic Carbon Framework provides a methodology for quantifying soil organic carbon sequestration in projects for carbon credit creation, sold to voluntary carbon market buyers.			
Type	Private VCM	**Climate action**	Soil organic carbon
Approach to biodiversity co-benefits			
General sustainability requirement	**Sustainable Development Goals:** Beneficiary must contribute to at least two other Sustainable Development Goals. SDG impact shall be a primary effect and not "one off" or an effect generated in design, construction, distribution, start-up or decommissioning of the Project. The SDG Impact Tools are a mandatory part of the project development cy-cle. **Do no significant harm:** Requirements include three principles with impacts on biodiversity: Principle 9.1 - Landscape Modification and Soil. Requirement to ensure healthy soils. Biota in soils shall have to be identified, and appropriate measures shall be put in place to protect them.		

	Principle 9.10 High conservation value areas and critical habitats. No project that potentially impacts identified habitats shall be implemented unless certain perquisites are in place. Principle 9.11 - Endangered Species. Projects should have no negative impact on any recognised Endangered, Vulnerable or Critically Endangered species.
Transparency requirements	**Transparency:** All Project Documentation, except confidential information, must be made publicly available through the Impact Registry. **Stakeholder consultation & engagement:** General requirement for stakeholder consultation and engagement. There are specific requirements with respect to the two principles: Principle 9.10 - High Conservation Value Areas and Critical Habitats. The opinions and recommendations of an Expert Stakeholder shall be sought and demonstrated as being included in the Project design. Principle 9.11 - Endangered Species. The opinions and recommendations of an Expert Stakeholder shall be sought and demonstrated as being considered and incorporated into the project design.
Positive-/negative Lists	**Suitability of area:** Principle 9.10 High conservation value areas and critical habitats. No project that potentially impacts identified habitats shall be implemented unless certain perquisites are in place.
Monitoring	**Quantitative approach:** Beneficiaries have to submit GIS vector layers including biodiversity areas (A map with a polygon reflecting the boundaries) at the stage of project certification.
Multiple Payments	None
Source	
Gold Standard 2020. Soil organic carbon framework methodology. SDG: 13 Climate Action. Version 1.0. Accessed 07.10.2022. https://www.goldstandard.org/project-developers/standard-documents	

IFC - Social and Environmental Performance Standard 6 Biodiversity Conservation

Introduction			
The IFC is an international financial institution that offers investments, advisory, and asset-management services and is a member of the World Bank. The Social and Environmental Performance Standard 6 Biodiversity Conservation are a part of IFC's Sustainability Framework, which aims at managing risk associated with IFC's global private sector development investments.			
Type	Private investment criteria	**Climate action**	General
Approach to biodiversity co-benefits			
General sustainability requirement	**Do no significant harm:** In case of negative impacts on biodiversity, the beneficiary is required to apply a mitigation hierarchy (avoid, minimize impacts, restore, offset) to achieve no net harm.		
Transparency requirements	**Stakeholder consultation & engagement:** Ongoing stakeholder consultation throughout planning and implementation phase, managed through a		

	Stakeholder Engagement Plan. Consultation with stakeholders who will be adversely affected to ensure informed consultation and participation.
Positive-/negative lists	**Suitability of area:** Impacted habitats are divided into three categories: modified, natural, and critical, with more stringent requirements for more valuable habitats (i.e. natural and critical habitats), including employment of experts to identify expected biodiversity impacts and mitigation actions.
Monitoring	**Quantitative approach**: Performance Standard 6 covers biodiversity conservation and sustainable management of living natural resources. For projects potentially impacting natural or critical habitats, experts must be employed to identify impacts. For modified habitats, non-experts can be involved. **Qualitative approach:** IFC clients must complete an impact assessment to understand potential negative impact on biodiversity (and other issues e.g. labour and working conditions). They must establish an Environmental and Social Assessment and Management System to manage, monitor and apply a mitigation hierarchy. **Monitoring**: Ongoing monitoring is to be established as part of the Environmental and Social Assessment and Management System.
Multiple Payments	None
Source	
International Finance Corporation (2012) Performance Standard 6 Biodiversity Conservation and Sustainable Management of Living Natural Resources. Accessed 16.08.2022. https://www.ifc.org/wps/wcm/connect/3baf2a6a-2bc5-4174-96c5-eec8085c455f/PS6_English_2012.pdf?MOD=AJPERES&CVID=jxNbLC0 International Finance Corporation (2012) Performance Standard 1Assessment and Management of Environmental and Social Risks and Impacts. Accessed 16.08.2022. https://www.ifc.org/wps/wcm/connect/8804e6fb-bd51-4822-92cf-3dfd8221be28/PS1_English_2012.pdf?MOD=AJPERES&CVID=jiVQIfe	

MoorFutures (Version 2.0)

Introduction			
A result-based voluntary carbon market scheme to incentivise the rewetting of peatlands to reduce GHG emissions in Germany. The updated methodology version 2.0 extends the basic standard to include additional ecosystem services in tandem with emission reductions.			
Type	Private VCM	**Climate action**	Managing peatlands
Approach to biodiversity co-benefits			
General sustainability requirement	**Multiple benefits:** Standard 2.0 includes a methodology for measuring and reporting impact on multiple benefits provided by peatlands, including biodiversity (as well as impacts on water quality, flood mitigation, groundwater stores, and evaporative cooling.		
Transparency requirements	**Transparency:** MoorFutures credits are explicitly linked and attributed to specific projects that can be visited on site. For every project, clear and accessible documentation is available with information on location and status of the project area, as well as on the assessment of emission reductions and additional ecosystem services (including biodiversity outcomes). MoorFutures are registered at the regional level through regional coordinating bodies − e.g. in Mecklenburg-Western Pomerania and Brandenburg by the relevant ministries.		

	Stakeholder consultation & engagement: Local and regional representatives plus stakeholders should be involved in decision-making processes as early as possible.
Positive-/negative lists	None
Monitoring	**Quantitative approach:** Indicators are used to assess the effect of peatland rewetting on biodiversity. Indicators are species, species groups, or communities, which are expected to react to rewetting within the project time period. The standard offers two monitoring approaches a simple approach that assumes standard values for different land cover types (referred to as the BEST (Biodiversity Evaluation Site Type) approach, and uses these to calculate a biotope value, defined using compensation area´ equivalents. The second approach is a "premium" approach, which measures the number of indicator species using an indicator species model (unit: number of species or scores). Models exist already for birds and arthropods, could be developed with existing data for vascular plants/mosses; while more work needed to estimate amphibian populations. **Monitoring:** Monitoring with standard approach is done by re-estimation of the project scenario every ten years: low cost, but relatively l ow accuracy. Monitoring with premium approach is done by re-mapping of indicator species every ten years, at higher cost and accuracy. Should leakage occur, it will be quantified and accounted for.
Multiple payments	**Multiple payments:** The methodology 2.0 discusses the idea of unbundling GHG reduction and co-benefits (ESS) in order to sell co-benefits (ESS) on a dedicated market (i.e. biodiversity market). **Biodiversity results-based payments:** Premium approach measures number of indicator species and is monitored by re-mapping indicator species every 10 years.
Source	
Josten et al. 2015. MoorFutures. Integration of additional ecosystem services (including biodiversity) into carbon credits – standard, methodology and transferability to other regions. Accessed 07.10.2022. https://www.moorfutures.de/app/download/31771524/BfN-407_MoorFutures-ecosystem-services_2015.pdf	

Nori – Cropland methodology

Introduction			
Nori offers a marketplace to host the sale of carbon removal certificates. It exclusively focuses on removing CO_2 from the atmosphere. For now, only USA agricultural projects that focus on storing carbon dioxide in soils can apply.			
Type	Private VCM	**Climate action**	Soil organic carbon
Approach to biodiversity co-benefits			
General sustainability requirement	None		

Transparency requirements	None
Positive-/negative lists	None
Monitoring	None
Multiple Payments	None
Source	
Nori (2021). Croplands Methodology – Version 1.3. Accessed 16.08.2022. https://nori.com/resources/croplands-methodology	

Verra - Jurisdictional Nested REDD+ (JNR)

Introduction			
Verra is a non-profit corporation located in the USA offering international, voluntary mechanisms for carbon mitigation and removals, commonly sold as offset credits. The JNR is an accounting and verification framework for jurisdictional REDD+ programs and nested projects. Jurisdictional programs are monitored and avoid or reduce emissions and generate removals at the scale of a jurisdiction (e.g. a region), rather than the standard VCM scale of an individual project.			
Type	Private VCM	**Climate action**	Forests & soil organic carbon
Approach to biodiversity co-benefits			
General sustainability requirement	None		
Transparency requirements	**Stakeholder consultation & engagement:** Requirement on transparent communication with stakeholders about safeguards, ongoing communication and grievance procedures, with monitoring/reporting of how this is considered.		
Positive-/negative lists	None		
Monitoring	None		
Multiple Payments	None		
Source			
Verra (2021) JNR Requirements Scenario 2. Accessed 16.08.2022. https://verra.org/wp-content/uploads/2021/04/JNR_Scenario_2_Requirements_v4.0.pdf			

Verra - VCS Indigo Ag methodology for improved agricultural land management

Introduction
Verra is a non-profit corporation located in the USA offering international, voluntary mechanisms for carbon mitigation and removals, commonly sold as offset credits. The Agricultural Land Management

methodology provides procedures to estimate the greenhouse gas emission reductions (CH_4, N_2O, CO_2) and removals resulting from a project that adopts improved agricultural land management practices focused on increasing soil organic carbon (SOC) storage.			
Type	Private VCM	**Climate action**	Soil organic carbon
Approach to biodiversity co-benefits			
General sustainability requirement	**Sustainable Development Goals:** The beneficiary must demonstrate that a project contributes to at least three SDGs by the end of the first monitoring period, and in each subsequent monitoring period. **Do No Significant Harm:** The beneficiary must identify potential negative environmental and socio-economic impacts and take steps to mitigate them.		
Transparency requirements	**Stakeholder consultation & engagement:** The beneficiary has to conduct a local stakeholder consultation prior to validation (including identification of potential risks). There must be an ongoing communication with stakeholders, which must be demonstrated to verifiers. All projects are subject to a 30-day public comment period.		
Positive-/negative lists	**Negative list:** Cannot occur on wetland or on land cleared of natives within the last 10 years. **Avoid invasive species:** Forbidden to introduce invasive alien species		
Monitoring	**Qualitative approach**: The beneficiary must identify potential negative environmental and socio-economic impacts and take steps to mitigate them.		
Multiple Payments	None		
Source			
Verra (2022) VCS Standard v4.3. Accessed 16.08.2022. https://verra.org/wp-content/uploads/2022/06/VCS-Standard_v4.3.pdf Verra (2020) VCS Methodology VM0042 Methodology for Improved Agricultural Land Management. Version 1.0. Accessed 12.08.2022. https://verra.org/wp-content/uploads/2020/10/VM0042_Methodology-for-Improved-Agricultural-Land-Management_v1.0.pdf			

EU Common Agricultural Policy (CAP) 2023-2027

Introduction			
The CAP is the agricultural policy of the European Union implementing a system of agricultural subsidies. To receive payments, all beneficiaries must meet a set of mandatory rules (known as “conditionality”), comprising so called Good Agricultural and Environmental Conditions (GAECs). Seven out of the nine GAECs involve climate action and biodiversity issues. In addition, beneficiaries can apply eco-schemes on a voluntary basis, which comes with additional funding.			
Type	Public	**Climate action**	General
Approach to biodiversity co-benefits			

General sustainability requirement	**Multiple benefits:** All Beneficiaries must implement the nine GAECs with seven of them involving climate action and biodiversity issues (GAEC 1,2,3,6,7,8,9).
Transparency require-ments	**Stakeholder consultation & involvement:** According to the regulation 2021/2115 Member States are required to effectively involve and consult part-ners in the preparation of the CAP strategic plan.
Positive-/negative lists	**Positive/Negative List:** GAEC 3, 8 and 9 involve negative lists, by banning specific agricultural measures: GAEC 3 bans the burning of arable stubble (negative list). GAEC 8 bans the cutting of hedges and trees during bird breeding and rearing season and op-tional measures for avoiding invasive plant species. GAEC 9 bans the conver-sion or ploughing of permanent grassland designated as environmental-sensi-tive permanent grassland in Natura 2000 sites.
Monitoring	None
Multiple Payments	**Multiple payments:** Beneficiaries receive income support through pillar I if they comply with the conditionality (GAECs). In addition, they can receive fi-nancial support if they apply eco-schemes on a voluntary basis.
Source	
REGULATION (EU) 2021/2115 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL. Accessed 12.10.2022. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R2115&from=EN	

EU Sustainable Finance Taxonomy (Activity: Animal production) – Technical Expert Group Proposal

Introduction			
The EU Taxonomy is a classification system that identifies which parts of the economy are considered as sustainable investments. The activities are assessed against six environmental objectives, including biodi-versity protection and restoration. Minimum criteria are set for each objective and activity. The development of the criteria and values was supported by a technical expert group. Here, we assess the technical expert group’s proposals for the activity Animal Production. Note: These were never adopted into the EU Taxon-omy, which was became law excluding the agriculture sector.			
Type	Public	**Climate action**	General
Approach to biodiversity co-benefits			
General sustainability requirement	**Do no significant harm:** Beneficiaries must make significant contribution to at least one of six environmental objectives (mitigation, adaptation, water, circular economy, pollution, biodiversity,) and Do No Significant Harm to all other ob-jectives. Do No Significant Harm criteria are specified for each environmental objectives (e.g. no stubble burning, protect wetlands). These are managed through the Farm Sustainability Management Plan (FSMP).		
Transparency require-ments	None		

Positive-/negative lists	**Positive-/negative list:** Unclear (based on current published elements of Taxonomy) **Suitability of area:** Specific requirements for managing areas near wetlands, biodiversity sensitive neighbouring areas (e.g. NATURA 2000 sites), and specific land types (e.g. natural grasslands, semi-natural grasslands etc). **Invasive species:** In biodiversity-rich areas, invasive alien species are removed to the extent possible without recourse to chemicals. **Native species:** Promotes farming of pure breeds (to 50% of stock).
Monitoring	**Quantitative approach:** Predominantly qualitative but some quantitative minimum requirements, e.g. maximum continuous area without biodiversity rich land is 3ha. **Qualitative approach:** A spatial and temporal FSMP sets out the agricultural holding's strategy to meet set criteria and acts as the documentation to evidence compliance. The FSMP includes information on biophysical environment, cropping system and land use change and identifying management practices that ensures compliance. **Monitoring**: Independent third-party verification of plan and annual farm records: at year zero, then every 3 years. Group verification allowed (i.e. farms within 10km).
Multiple Payments	None
Source	
Platform on Sustainable Finance (2022) PLATFORM ON SUSTAINABLE FINANCE: TECHNICAL WORKING GROUP PART B – Annex: Technical Screening Criteria. Accessed 15.08.2022 https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/220330-sustainable-finance-platform-finance-report-remaining-environmental-objectives-taxonomy-annex_en.pdf	

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