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White paper

Incentivising carbon farming; policy recommendations from the Carbon Farming project

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Summary

Farmers can contribute significantly in a positive way to our climate challenges and the climate objectives that have been formulated to reduce Greenhouse gas (GHG) emissions by 2030 and achieve climate neutrality by 2050. Through improved agricultural management, farmers can remove carbon dioxide (CO_2) from the atmosphere and store it sustainably in the soil in the form of soil organic carbon (SOC). This type of agricultural practice is called carbon farming. The Interreg North Sea Region Carbon Farming (CF) project was initiated with the aim to increase the awareness of the possibilities of carbon farming and to motivate farmers to get started with carbon farming by developing new business models.

Based on a conducted survey, three main obstacles for farmers to implement carbon farming were identified:

1. **insufficient knowledge,**
2. **restrictive policy**
3. **economic reasons.**

When tackling these three obstacles simultaneously we can claim the significant potential that carbon farming could have for companies, society and farmers!

It is important to clarify (1) the problem statement of these obstacles and how farmers are experiencing these obstacles in order to work on (2) possible solutions and incentives to overcome these obstacles and (3) propose recommendations on how to motivate the farmers to implement carbon sequestration (CS) measures.

Abbreviation list

C	: Carbon
CAP	: Common Agricultural Policy
CF	: Carbon farming
CO_2	: Carbon dioxide
CS	: Carbon sequestration
e.g.	: exempli gratia; for example
etc.	: et cetera; and so on
ETS	: Europe trade emission scheme
EU	: European union
GHG emissions	: greenhouse gas emissions
i.e.	: id est; in other words
SOC	: Soil organic carbon

1. Problem statement

- **Insufficient knowledge:** CS measures can be applied in many different ways and combinations, with various outcomes.
  More knowledge among farmer is needed on practical implementation and outcome of combinations.
- **Economic uncertainty:** There is uncertainty among farmers about the costs-benefits balance, since carbon farming is a lengthy process with a variable outcome.
- **Restrictive policy:** There are many targets and obligations for farmers, making it difficult to take the right decisions for each farm.

2. Solutions and challenges identified by the Carbon Farming project

- **Insufficient knowledge:** from a literature study and interviews with various stakeholders, five CS techniques have been identified as the most valuable. Three important criteria were taken into account: additionality, permanence and prevention of leakage.
- **Economic uncertainty:** the CF consortium identified four categories of voluntary business models that can be used to valorise carbon sequestration.
- **Policy restrictions** and opportunities for the local economy: during the project's we learned about opportunities and incentives for policy makers to be aware of, when promoting local carbon offset and facilitating new collaborations.

3. Policy recommendations

We have experienced that policy restrictions have a major impact on how CS techniques are implemented, (though this was not the initial focus of the CF project) Because of this, great opportunities are being lost. Thus, we have included recommendations in this white paper that are based on our experiences during the project and on many discussions with farmers, agricultural advisors and knowledge institutes. Policy makers can stimulate carbon sequestration by farmers in the following ways:

- Overcome the knowledge barrier and focus on practical application of CS techniques.
- Provide and support financial incentives through policy programmes and private markets. These two ways of economic incentives could, and probably should, be combined.
- Developing a holistic policy framework in which the different objectives (climate, biodiversity, water,) do not conflict with each other at farm level, but provide a clear and motivating framework for farmers. This is to avoid contradictory policy and administrative tangle for farmers.
- **Our most important and general recommendation would be to focus on how to motivate farmers and to not make CF compulsory. Farmers fear that obligations will limit them in making CF tailor-made to their farm, as not all CS measures are fitted for all farms. Making it compulsory would take away their creativity and motivation.**

1 Introduction

Flower strip

1.1 Introduction to the Carbon Farming project and the objective of this paper

In 2018, we started the implementation of the Carbon Farming (CF) project as an initiative from 7 organisations from Belgium, Netherlands, Germany and Norway, a combination of organisations representing farmers, farm advisory services and knowledge institutes and with support from the interreg North Sea Region programme. The aim of the project was to increase the awareness of the possibilities of carbon farming and to motivate farmers to get started with carbon farming by developing business models for carbon sequestration.

Carbon farming has a lot to offer us. Through an improved agricultural practice, farmers can remove CO_2 from the atmosphere and store it sustainably in the soil in the form of SOC. With this, farmers can make a major contribution to our climate challenges and climate objectives. But carbon farming has even more to offer: this sustainable way of agriculture and the increase in soil organic matter content that it offers, also has a positive effect on soil life and thus biodiversity, on soil water retention capacity and thus on resilience to climate extremes and on soil fertility and production capacity and thus on a sustainable food supply.

There are so many benefits, why don't all farmers immediately switch to carbon farming? Of course, we already had ideas about this at the start of the project. We assumed this was due to lack of knowledge, lack of (financial) incentives and practical obstacles. Hence, the main themes of the project have become: (1) increasing farmers' knowledge of carbon farming; (2) the development of business models to reward farmers and (3) the development of 15 tangible showcases in which farmers get to work with carbon farming and are rewarded for it.

In 2018, carbon farming was still new territory. The potential to contribute to our climate challenge was surfacing here and there, but it was not yet explicitly on the policy agenda. Now in May 2021, three years later, carbon farming is high on the international policy agenda. Frans Timmermans, Executive Vice-President of the EU, has given carbon farming an important place in the EU's climate strategy. On April 27, 2021, the EU launched a "Technical Guidance Handbook - setting up and implementing result-based carbon farming mechanisms in the EU", the result of a two-year study on carbon farming. And at the end of 2021, the European Commission aims to present its "Carbon Farming Initiative".

We warmly welcome this, because farmers can make an important contribution to our climate problem and at the same time will enhance and protect soil fertility and so the more farmers participate, the better! However, it is important that we understand what motivates or hinders farmers and how policy responds to this. This is why we want to share our experiences and lessons learned from our CF project in this paper so that policymakers at all levels (local, regional, national and European) can use this to improve their policies and ultimately motivate as many farmers as possible to participate in carbon farming.

1.2 Climate challenges and growing interest for carbon farming

Since the industrial revolution, from 600 Gt total anthropogenic emissions between 1870 and 2014 worldwide, 25% are from land use change[I]. In the atmosphere carbon is present in the form of CO_2. Its is incorporated by plants via photosynthesis and enters the soil via root exudates, litter and harvest residues. In soil it is stored as SOC. Soil management and cropping practices has a major impact on how much carbon will be retained in the soil. By appropriate management more carbon can be kept in soils than is released back into the atmosphere through organic matter decomposition. CO_2 contributes greatly to the Greenhouse Gas Emissions (GHG emissions) that according to the latest resolutions of the EU Parliament are to be reduced by 55% by 2030 compared to 1990 levels. In 2017 agriculture contributed nearly 9% of the EU's GHG emissions. This means that agriculture has an important task to reduce these GHG emissions. On the other hand agriculture can also make a major contribution to solving this problem[II]. More than one-third of the total area of the EU is farmland and thus one-third of the European area might be used to fix additional CO_2 from the atmosphere and store it in the soil[III]. These are the key processes of the carbon cycle (Figure 1). Carbon farming is an opportunity and can complement efforts to reduce GHG emissions by 2030 and achieve climate neutrality by 2050.
Due to increasing consciousness of society and

growing pressure to address this urgent issue, more and more businesses are looking, voluntarily or not, for possibilities to compensate for their emissions. Today, there are already many projects and initiatives to do this, yet mostly in developing countries and not in countries where most of the emissions are produced. Why not compensate locally to current foreign projects? This would open up opportunities in various ways such as local partnerships boosting local economies, new business models and it would offer more transparency of carbon offset efforts while at the same time the other benefits of carbon farming, such as an increase in biodiversity and resilience of soils against climate extremes, would also have their impact in this region.

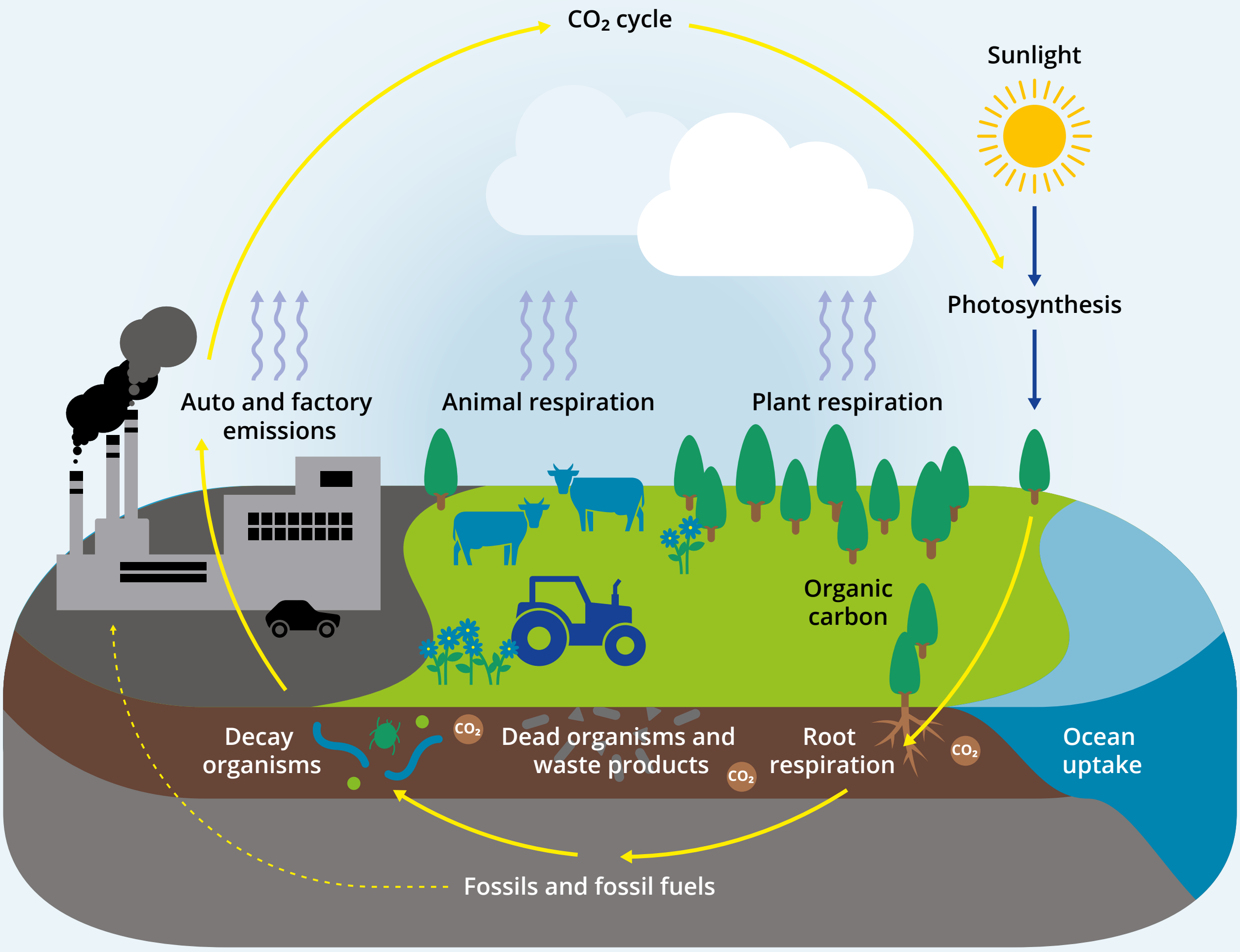


Figure 1: the Carbon-Cycle: SOC is stored in soils and in exchange with the carbon in the atmosphere in the form of CO_2. Carbon is extracted from the air by plants and used as a building element for their organic material. When plants die, this organic material ends up in the soil where it serves as food for soil life. This soil life is important for the structure of the soil and subsequently for the retention of minerals and water. The carbon in the soil can be returned to the atmosphere through natural processes (e.g. respiration of soil organisms).

1.3 Carbon farming and its multiple benefits

Soils are both a sink and source of CO_2[IV]. The decomposition of SOC is necessary for microorganisms as an energy source and for the nutrient availability for crop production[V]. Thus, landowners should conduct smart agricultural management practices to decompose only the necessary amount of SOC to avoid the CO_2-emission and the pollution of groundwater by unnecessary nutrient mobilisation and thereby to save the soils from degradation. It is also possible not only to maintain, but also to enrich the SOC and to reach a new SOC equilibrium in soils by using adequate production methods. Lal (2002)[VI] estimates that such improved management could restore 60 to 70 % of the C lost from soils since the industrial revolution.

Carbon farming means farming to sequester additional carbon in the soil. There are many ways to do this: from small adjustments on farm level - like planting cover crops - to changes in the entire farming system - like enriched crop rotations or agroforestry.

The SOC content is a result from the ratio of supply and mineralization of organic matter in the soil. Mineralization is promoted by heat and aeration (e.g. during ploughing). A permanent plant cover consisting of a variety of plants is of special importance to reduce this mineralization (by shadowing), to maximize the production of roots in different depths and to prevent losses of organic matter by erosion. Woody plants offer considerable additional effects here and at the same time bring nutrients that were leached in deeper soil layers back into the system. Increasing SOC content on agricultural land has four main positive effects:

1. CO_2 is removed from the atmosphere and fixed in the long term.
2. GHG emissions associated with agriculture can be reduced, since increase of SOC since soil organic matter is a nutrient source and buffer and especially when legumes are introduced in carbon farming systems the use of energy intensive mineral fertitilizer can be reduced.
3. Agricultural production becomes more resilient to the consequences of climate change in the form of droughts and heavy rainfall.
4. There will be a positive influence on soil health, soil life and biodiversity.

1.4 Scope of this paper

In our project we have focused on motivating farmers to get started with carbon farming through supply and the development of revenue models. Our recommendations in this "White Paper" therefore focus on these areas. In addition, we only look on activities aiming at increasing SOC on mineral soils, through various measures for sustainable soil management, planting shrubs and trees in agriculture (agroforestry) and grassland management. We do not focus on reducing emissions in agriculture, for example through rewetting peatlands or through measures to reduce emissions in livestock farming. Consequently, we have not focused on the full GHG balance of agriculture. This is of course a very important point for attention in policy, but this paper and our recommendations do not consider these aspects connected to the reduction of emissions in agriculture. Yet we put forward three main conditions for a CS technique before it can be considered as relevant: additionality and permanence of CS measures and prevention of leakage.

2 Problem statement: what is limiting farmers to start carbon farming?

Essential soil organisms

Despite the positive impacts of carbon farming, many farmers have their reasons for not yet (fully) conducting measures to save SOC from unnecessary decomposition or to fix additional CO_2 from the atmosphere and to sequester it in soils for a long time. It is important to identify these reasons so we can pinpoint the obstacles that farmers face. With this knowledge we can work on possible solutions and incentives to overcome these obstacles and propose possibilities on how to motivate the farmers to take CS measures. To do so, in 2019 the CF consortium conducted a survey among the farmers, agricultural and non-agricultural chain-partners and stakeholders. The questionnaire was distributed in agricultural events, fairs, workshops and online through newsletters, websites and social media. The total number of participants was 539. Through, his survey, we mapped the current awareness in regard to CS possibilities, knowledge and perception amongst the stakeholders within the agri-food chain. The survey investigated whether the participant was familiar with the possibilities of carbon farming, as well as whether CS techniques were already applied and if so, which ones. In addition, we explored the possibilities by asking about the farmer's interest in certain techniques and what the obstacles were to applying them.

From the survey it appeared that 81% of respondents were aware that farmers can contribute to climate change mitigation by sequestering carbon in soils and 74% of the respondents had considered usage CS techniques to increase or protect carbon in their soils.

An outcome we want to highlight is the answer to the following question: 'What is actually preventing you from taking soil measures to improve carbon in soil?'. The participants could choose multiple options, but the main obstacles became very clear: insufficient knowledge (48%), restrictive policy (40%) and economic reasons (36%) (Table 1).

What is actually preventing you from taking measures to improve carbon in soil?

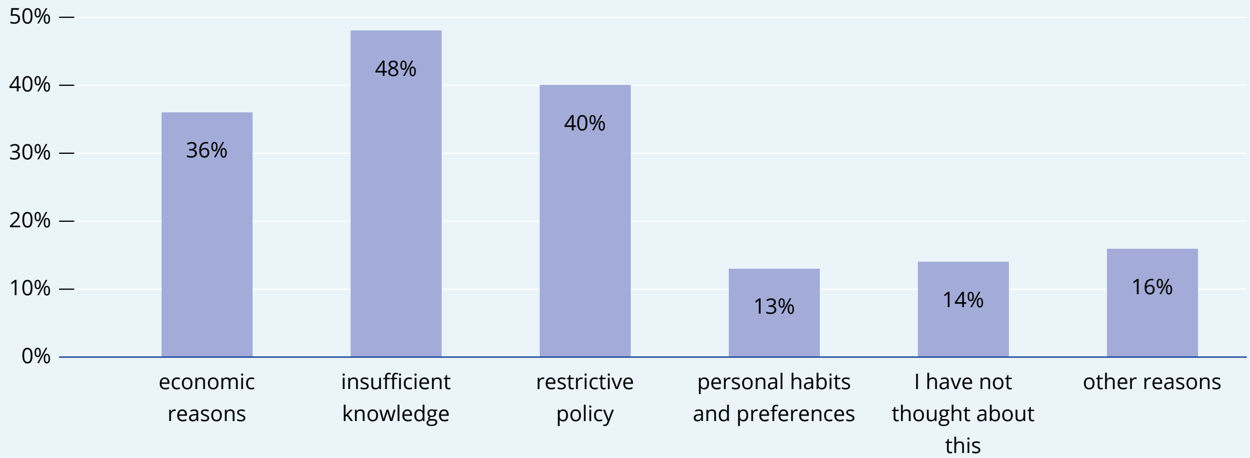


Table 1: The results on the question in the survey which obstacles the participant experience to adopt CS techniques

Among others, emerging business models involving generating and purchasing carbon credits based on C sequestration in soils could be a necessary way to incentivise farmers in their need for **economical support** in order to be able to implement more climate smart agricultural production. In addition, it is important that the necessary practical and technical knowledge is transferred from research to practice in an accessible way. Not only the **transfer of knowledge** in regard to CS techniques is important, but also the knowledge of the additional positive benefits, not only for climate mitigation and adaptation, but also for the farm management of the farmer. These positive outcomes for the farmers occur in the long term in the form of soil fertility and consequently as co-benefits such as increased crop production, fewer plant diseases and higher quality of the final product. In turn, these co-benefits can provide better financial returns in the long run.

It is remarkable that more farmers have indicated that they are experiencing difficulties in applying the CS techniques due to **restrictive policy** than due to economic reasons. While the main focus of the CF project was to create more economic incentives by developing new business models for the agricultural sector, there is clearly also a need for tackling restrictive policy and making policy makers aware of these issues.

Only by working on knowledge development and transfer, economic incentives and solving and limiting restrictive policy, can we claim the significant potential that carbon farming could have for companies, society and farmers!

2.1 Insufficient knowledge

2.1.1 Patchwork of knowledge

A growing number of farmers are aware of the CS measures and are willing to implement them. However, CS measures can be applied in different ways, soils have different histories and capacities and thus have different carbon sequestering potential. For example, a farmer can apply cover crops, but depending on sowing and harvest date as well as on the type of cover crop, the CS potential will differ. In addition, the way farmers integrate carbon farming in their farm management can also differ. Ranging from the implementation of a single or a couple of measures, to taking a whole new approach to farming and adopting the principles of, for example, regenerative farming. It can be argued that implementing carbon farming measures as part of a systems change results in better outcomes regarding CS, rather than implementing carbon farming measures in the existing farming system. This asks for more than implementation of knowledge on the farm level, rather, it begs for a paradigm shift in farming and the mindset of the farmer. The challenge is to identify the incentives that motivate farmers and to adopt carbon farming measures as part of an integral systems change regarding soil management and the management of natural resources in general. However, we should not neglect or fail to recognise the importance and potential of starting with implementing carbon farming measures in the existing farming systems, as this is the first step in the right direction.

Farmers on their own cannot initiate this paradigm shift, they need the guidance and unified knowledge that comes from research and field trials, as well as to consider the economic margins. However, the integrated systems approach mentioned above, is often not taken into consideration in the set-up of scientific studies. **Therefore, the effects of carbon farming measures are mostly being studied separately and not as a combination of measures**. Researchers and farmers would both benefit from a closer cooperation, where studies are being tailored to the real-life situation in the field and where researchers can benefit from the experiences that farmers share with them, fostering more of a dialogue between both stakeholders.

In the CF project we experienced that farmers want to adopt a set of measures that might interact with each other and enhance the effectiveness to store C in soils. This is a consequence of the fact that on the one hand, they receive advice from different, often supplier related, commercial advisors and that a lot of information can be found on the internet about carbon farming and the implementation of CS techniques. On the other hand, they have to pick out measures which may not interact with each other at all just to be in line with the legislation regionally and at European level.

In addition, there is a general need and demand for advice tailored to the farm specific situation. This advice must contain information about how to navigate the overwhelming amount of information that is available and offer guidance on how to adapt farm management to the proposed combination of measures.

2.1.2 Difficulties in predicting and measuring carbon sequestration results

The enrichment of carbon stocks in soils needs to be followed up and quantified. Here major problems lie in sampling and analytical errors and, most problematic, in variability of SOC that are related to natural processes. Soil organic matter is in a dynamic equilibrium of input and decomposition and is determined by biomass supply, climate, soil texture, site management and site history. Whereas organic matter input and management are addressed in carbon farming initiatives, climate and site history influence the general direction of SOC development and possible gains, whereas soil texture defines the total capacity. Generally, decomposition of organic matter increases from clayey to coarse-textured soils and with increasing temperatures under variable humidity.

Today, determining total carbon and the determination and subtraction of carbon bound in carbonates is the routine procedure in practical SOC analytics. This approach follows the theory that all sources of SOC will be subject to decomposition over time. It offers a robust value for the status of organic matter in soils, in addition techniques like remote sensing and satellite imaging might contribute to monitoring. Futhermore, the determination of carbon in different binding forms, different stability and different physical protection in soils is possible, but is very expensive.

Due to the expected variability of analytic results SOC analyses should be underpinned with verified management data, e.g. by standardized field records. In addition, a visual documentation of the vegetation and soil structure (e.g. from spade diagnosis or soil profile evaluations) could underpin the efforts of the farmers and illustrate physical results of management changes. However, taking measurements in the field entails a lot of costs. It is therefore important to optimize the possibilities of modelling of the development of SOC in order to be able to make the best possible prediction with as few measurements as possible. Analytical results can be used to improve modelling.

Storing carbon in soils through CS techniques is still a long-term process with a rather uncertain outcome in the long run. The uncertainty of whether a predefined amount of carbon will actually be stored in the soil and for how long can certainly play a role in farmers' hesitation start with carbon farming.

Farmer with his compost

2.2 Economic uncertainty

There is still a lot of uncertainty about costs and benefits in relation to carbon sequestration techniques. Research has shown that all measures for sequestering carbon in soils have their first visible impact after a time span of at least five years, but even more so at ten years. This long time span creates great hesitation among farmers, and with good reason. On the one hand, we have the potentially necessary extra labour, time, investments or other costs (e.g., yield losses, buying cover crop seeds, buying compost, planting and maintaining trees and shrubs, new mechanisation because of reduced tillage systems, etc.) to apply the measures. On the other hand, there is the additional cost of taking samples and monitoring carbon in the soil. But production costs might also decrease, for example by use of less fuels and/or less machinery when stopping with tillage. However, in the short term the costs might not be balanced out by the benefits. Farmers often do not have the economic flexibility to make this switch in farm management. Due to the high variability in the possible measures and in the potential for carbon enrichment the average cost per measure or per stored ton carbon must be calculated specifically for each farm.

The additional costs with no economic margin and the long time span of at least 5 years, often in combination with the fact that there is only a pay-out when the minimum value of carbon in the soil is achieved, it makes sense that farmers would have doubts about switching to carbon farming techniques. A feasible and proper valorisation for their effort is necessary. **This indicates that only the willingness of farmers is not enough - the development of new revenue models is also a necessary incentive to implement carbon farming in the agricultural sector.**

2.3 Contradictory and restrictive policy

The third obstruction according to farmers to apply carbon farming in its entirety, is contradictory and restrictive policy. This we learned both from the questionnaire performed in 2019, as well as by listening and discussing directly with 'carbon farmers'. These 'carbon farmers' are convinced of the long-term benefits and eager to learn which measures apply best to their farm and soil type, yet they argue that they are limited in their full carbon farming potential by policy. In this white paper we want to point out the main barriers, contradictory and restrictive policy, that prevent farmers from starting or continuing to take CS measures. Unfortunately we noticed several farmers stating they had to stop with certain CS measures, noting, for example, *"I have used compost on my farm for 20 years, but was compelled to stop because of the new stricter manure legislation (MAP6 in Flanders)".*

Yet often some restrictions in policy are needed to protect vulnerable areas. The main issue for policy and farmers is to find the right balance between climate impact, environmental needs, administrative possibilities and economic feasibility. **Currently, for many farmers imbalance and contradiction between the different policy objectives is leading to the feeling of the impossibility of contributing and succeeding in all objectives.**

In general farmers are expected to contribute to many different objectives and often have to take into account and adapt to new policies. Farmers need to meet policy demands in regard to:

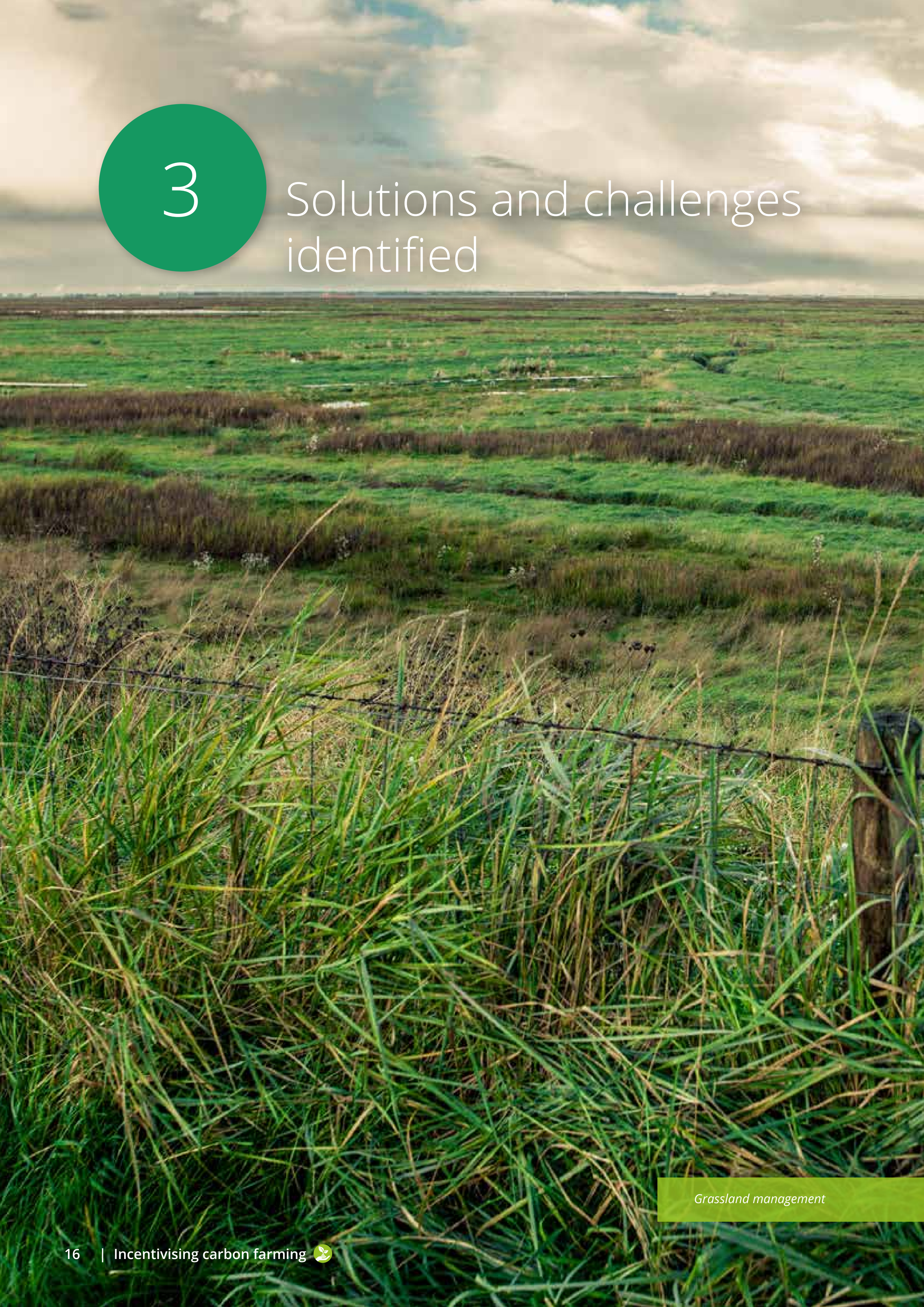
- contributing to water quality through the Nitrate Directive;
- strict boundaries in nitrate and phosphate use and leakage;
- lowering their greenhouse gas emissions;
- contributing to increased biodiversity;
- lowering ammonia emissions;
- increasing carbon content of agricultural soils;
- lowering their water usage for crops and animals
- application of cover crops in order to receive income support from CAP
- maintenance of permanent grassland
- ...

Some of the above-mentioned demands are legally obliged and can lead to penalties if not met. Some of the above-mentioned demands are 'goals', yet not legally obliged. For example, the need to increase SOC content is partially limited and even contradictory next to the strict boundaries in nitrate and phosphate use and leakage. This is an example of how different policy goals such as climate and biodiversity come together on the farm, which can lead to conflicting rules in practice if not properly coordinated.

To summarise the problem statement in regard to policy:
How can and will policy makers ensure that farmers can make a positive commitment to meeting all these different targets?

Undersow of grass in corn

3 Solutions and challenges identified



Grassland management

Within the project, we have brought together the various challenges that farmers face before and during the application of CS techniques. The consortium, with its various knowledge and expertise, searched for solutions to lower the barriers and to stimulate farmers. During the course, we have experienced ourselves that there is no one-size-fits-all solution and there will always be work to be done on stimulating and implementing carbon farming. Nearing the end of the CF project, some challenges were identified and are worth highlighting. In this section, we will elaborate on what we have learned during the project and which challenges we have experienced during the project.

3.1 Answers to insufficient knowledge

3.1.1 Stitching up the patchwork of knowledge

Despite the fact that carbon farming is gaining attention, there is still work to be done to promote this way of farming. Several actions were undertaken to increase awareness of carbon farming.

For the general introduction of carbon farming, an animated film was made about the basic principles of carbon farming itself and the CF project, which was distributed on the different communication channels of the different partners such as websites, social channels and newsletters.

Besides the general communication, the focus was mainly on four important groups: landowners, companies and enterprises, researchers and policymakers. For the farmers, presentations, workshops and three demonstration days were organised where soil management and the most promising CS techniques were discussed. Companies and enterprises were actively searched for via the SUSANOVA platform (media platform for sustainable entrepreneurship)[VII] in order to make them aware of the advantages and their possible role in carbon farming. The different researchers were brought into dialogue with each other to link the data and information from the CS techniques that have already been researched and described. As a final group we communicated with the policy makers. Through one-on-one conversations the governmental bodies were informed about this way of farming and the solutions it can offer to different environmental issues.

In order to bring together and combine the outputs of the different actions above, we connected these different knowledge pools. The different partners of the CF project organised several meetings and co-creation groups to exchange knowledge and share experiences from and between farmers, researchers and representatives of the agricultural sector and policy makers.

3.1.2 Framing most promising carbon sequestration techniques

In order to set-up new collaborations between farmers and companies or organisations that want to invest in or compensate through carbon farming techniques, a common understanding and view on the CS potential is indispensable. Parties that invest in CS by farmers want to be sure that the amount of carbon they pay for is being sequestered and farmers also want to be sure that they will actually deliver the promised results. So farmers want to know which measures are feasible for them to take, how to implement them and what carbon sequestration potential they have.

Therefore the different possible measures and their potential to fix CO_2 from the atmosphere and store carbon in soils were mapped out. Besides the figures, it is important to know whether the measures are manageable or even possible in practice. By practice, we mean for instance farm management (e.g., economic aspect, type of farm, legislation) and land management (e.g., type of soil, crop rotation, weather conditions). For this reason, different representatives covering the agricultural sector with expertise in CS techniques, each with a different perspective (e.g., politicians, advisers, researchers), were questioned about the possibilities and potential of certain techniques to fix CO_2 from the atmosphere and store carbon in soils. A wide range of numbers and possibilities were listed and a common list of 14 measures with figures was composed. The potential of a measure to store C in the soil increases when it is continiously integrated in crop rotations or grassland management. The carbon farming report ‘Inventory of techniques for carbon sequestration in agricultural soils’ is a fully detailed document of the 14 measures and there potentials. This inventory was based on thorough desktop research, which has shown that these measures only show their benefits over a longer time span of at least 5 years.

The 14 measures can be brought under the heading of five different categories:

1. Supplying biomass by cultivation systems (arable crops)
2. Protecting soil carbon during soil cultivation
3. Recycling and import of new carbon sources
4. (Permanent) pasture and management
5. Integrated landscape adjustments

Research has shown that regional differences in soil types and climate conditions have their impact on the speed and capacity of carbon storage in soils. As a result, the most promising measures may differ from region to region.

Based on the different factors, five measures can be considered as most promising for all regions when introduced in addition to the current status quo in farms:

Cover crops:
Continuous plant cover is the best insurance for soil health and function and draws carbon down into the soil and feeds and protect the soil ecosystem and soil structure. When cover crops are not harvested all biomass contributes to CS.

Enriching crop rotations to improve SOC stocks:
Organic carbon in agricultural soils is mainly delivered by the the plant roots, root exudates and aboveground biomass remaining on the field. Frequent soil tillage works contradictictory and enhances decomposition of organic matter. So crops with a dense and deep root system, of variable composition, covering the soil and that are leaving a high level of biomass on the field and multiannual crops, in combination with reduced.

Grassland management:
Estimates of the proportion of the earth’s land area covered by grasslands vary between 20 and 40 percent. Improved grazing management, adapted fertilization, sowing legumes, and improved grass species tend to lead to increased SOC. Very high rates of SOC enrichment can be expected when arable land is converted into grassland and also by elevated water tables in grassland.

4

5

Compost and solid manure:
The carbon content in the soil can be increased by adding compost and solid manure. Both contain organic matter in variable stage of decomposition and have variable and different C/N ratios, which influence their decomposition in soil. For the application of compost and/or solid manure, fertilization standards must be taken into account. Only compost and manure from additional grown biomass, compared to the situation before can be included for calculation of CS.

Agroforestry:
Agroforestry systems include hedgerows, shelterbelts, orchard grazing, alley cropping, poultry combined with short rotation coppice or fruit trees etc. The integration of trees and/or shrubs with crop and/or animal systems leads to many beneficial ecological and economic interactions.

However we did not manage to get a clear overview or common idea on the costs of each measure or ton of stored CO_2. Both the Dutch and Flemish partners made estimations on the costs to be made per sequestered ton of CO_2. The cost differs between the different measures, but can vary greatly within one measure as well. This can be explained by following reasons;

- Each farm is unique and therefore the initial situation can differ (e.g., the available tools and machines, the availability of workforce, market price of resources and end product, etc).
- The soil type has a high influence on the potential storage capacity.
- Availability of manure and compost, which can differ strongly between regions and seasonally.
- ...

Therefore it needs to be said that the numbers mentioned in this white paper are not to be applied in other regions or on specific farms without more detailed studies and calculations. These numbers only serve the need to show and prove that there is an actual cost in applying CS techniques and as well to give an idea on the order of magnitude of the cost.

Flanders[VIII] and The Netherlands[IX] questioned[X] not only researchers, but also advisors and farmers to end up with the fullest possible estimate in these circumstances. We tried to make a realistic estimate of the additional cost of a measure (compared to not implementing it) taking into account the most important cost items and the CS potential of a successful measure.

In regard to the CS technique of **cover crops and undersowing of grass in corn**, we noticed a range from €77,21 – 136 per ton CO_2/ha/year. This variety is mainly dependent on the variety of cover crop, potential yield loss and extra field work.

The highest range is noticed for the **application of (nature) compost**, which varies from €27-625 per ton CO_2/ha/year. The range depends on the manner of application (each year or each 3 years, type of compost, own compost or bought compost, livestock farm or arable farm, etc.). In regard to **application of solid animal manure** (range: €40-328,13 per ton CO_2/ha/year) a similar clarification applies. When applying compost and solid manure, the rules regarding additionality must also be taken into account.

Enriching the crop rotation (and **applying straw**) implies loss of certainty in regard to the known crop rotation and production. The main reason for monoculture of corn is certainty in regard to revenue. Implementing a new grain, with a more dense and deep rooting system, means finding a new market and the risk of loss of income. Potential cost price ranges from €109,38 – 441,2 per ton CO_2/ha/year.

3.2 Answers to economic reasons

During the project, we looked into the already existing market for carbon offsets. Currently, this market is mainly based on the compensation of CO_2 or other GHG emissions. Based on this existing market, we have developed new business models for the local agricultural sector. This as an opportunity and incentive for farmers to start with the implementation of CF.

3.2.1 Market of carbon offset

In order to valorise these carbon farming practices, the system of **carbon offset** can be used. A carbon offset is a reduction in emissions of CO_2 or other GHG emissions made in order to compensate for emissions made elsewhere. This system to compensate with carbon offset is connected with a price, which has led to the carbon offset market. A carbon market price gives an economic signal to polluting businesses to reduce and eventually discontinue their harmful activities contributing climate change. In this way, carbon pricing aims to stimulate the development of new, greener, more efficient, low-carbon technologies.

Before continuing, we need to emphasize and clarify the type of carbon offset we aim for with carbon farming. There are two types of markets for carbon offsets, **compliance** and **voluntary**:

- In **compliance** markets like the European Union (EU) Emission Trading Scheme (ETS) companies, governments, or other entities buy carbon offsets in order to comply with mandatory and legally binding caps on the total amount of CO_2 they are allowed to emit per year. Within the cap, companies receive or buy emission allowances, which they can trade with one another as needed. They can also buy limited amounts of international credits from emission-saving projects around the world.
  The CF project does not aim to develop a system qualified for the compliance carbon offset market, but focuses on the voluntary market.
- This voluntary market demand for carbon offset credits is generated by individuals, companies, organizations, and sub-national governments who purchase carbon offsets to mitigate their GHG emissions to meet carbon neutral, net-zero or other established emission reduction goals. The voluntary carbon market is facilitated by certification programs (such as the Verified Carbon Standard, the Gold Standard, the Climate Action Reserve) who provide standards and guidance and establish requirements for climate action projects developers to follow in order to generate **carbon offset credits**.

3.2.2 Voluntary market and carbon removal credits

In the voluntary market there are carbon offset credits which are measurable and verifiable emission reductions from certified climate action projects. These projects **reduce, remove or avoid GHG** emissions. In addition, we want to highlight the **carbon removal offset credits** (Figure 2). This type of carbon credit means that the CO_2 is actually captured or removed from the atmosphere and stored in soils or biomass. Thus, carbon removal offset credits drawing down the CO_2 concentration in the atmosphere which is different from the conventional way of carbon offsetting, which focuses on reducing emissions. As the carbon credits generated by farmers can be considered as **carbon removal credits, farmers** can be an important partner for companies who want to become **climate positive**, which is only possible through carbon removal.

Figure 2: Infographic on voluntary carbon (removal) offset market and types of climate action projects


Hedges and rows of trees

The market for carbon removal credits is growing as companies increasingly want to become **climate positive**. Many companies already pay for carbon neutrality by buying carbon credits that are made from projects that, for example, buy more sustainable wood stoves for developing countries (= GHG avoidance), e.g., Lotus Bakeries. These carbon credits used to offset emissions are generated mainly by a reduction of emissions elsewhere. In addition companies already invest in forestry projects (= GHG removal) outside Europe to claim climate neutrality, e.g. Zalando, or offer the opportunity to their customers to pay an additional fee for carbon neutral transport, such as travel agencies.

Why won't we offer the opportunity to compensate through local projects in Europe? An important trend noticed throughout the course of the CF project is that there is an increasing interest in **locally produced carbon (removal) credits**. Whereas in the beginning carbon credits were often required by planting trees in developing countries, **companies are now (in addition) looking for more local initiatives**. This is influenced by increasing questions about the reliability of these international 'far away' compensation projects and is reinforced by the increasing support and willingness of consumers to buy locally and support their local farmers and environment. In addition, they not only support the local farmers financially, but also provide local ecosystem services such as biodiversity and water storage.

The challenge here is that the current international carbon credit value is quite low. A study by Cevallos et al. (2019)[XI] noticed large differences in price when comparing different regions. Prices in EU carbon projects are usually higher (13 €/tCO_2, ranging from 6 – 110 €/tCO_2) compared to prices on international markets (average 4,6 €/tCO_2, ranging from 0,4 – 72 €/tCO_2). Of course the price depends on the type of carbon credit being considered. When having a look at the Daily EU ETS carbon market price, we notice a slight increase since 2018, yet after each crisis (see 2008) we see a decline in the carbon market price. Currently, while writing this white paper, we witnessed the highest carbon market price ever, €39,97 on February 12th 2021 (EMBER).

As explained in section 2.2. taking soil measures often demands extra efforts and costs for the farmers, therefore necessitating a fair 'carbon credit price'. In the CF project we calculated a cost price per ton of captured CO_2 ranging from €30 to €600, depending on the measure applied. In the CF project we found extra costs for the application of measures ranging between € 200 and € 600 per hectare and even more for agroforestry. It is incorrect to use the ETS prices as a basis for the voluntary carbon removal credits for different reasons (see below), yet many companies make this assumption.

a. ETS caps the total levels of carbon and other GHG emissions. It works as a system where caps are increasingly reduced every year and where businesses with low emissions can sell the allowances they didn't spend to others who spend more than they were allowed to. This creates the supply and demand of the carbon market.
b. Offsetting locally in the EU is more expensive due to different currencies, standards of living and lifespans.
c. The local voluntary carbon removal credits offer additional positive benefits: For example, they empower local farmers, protect ecosystems, restore forests or reduce reliance on fossil fuels. This is not the case for the ETS credits.

3.2.3 Four categories of voluntary business models identified by the CF consortium

The CF consortium identified four categories of voluntary business models that can be used to valorise CS. In our report, 'Research of existing business models to valorise carbon sequestration', more details and background research can be found. The four categories are defined by the stakeholder acting as initiator. These categories are visualised in the infographic (Figure 3):

a. Models within the agri-food chain

Within this model, we see opportunities for collaborations between enterprises involved within the agri-food chain. Often enterprises from within the agri-food sector, such as processors of milk and vegetables, retailers, distributors, etc. see opportunities to make their business more sustainable. To achieve this they are starting collaborations with farmers applying successful CS techniques.

b. Models outside the agri-food chain

More and more companies and organisations focus on climate and sustainability in their business model. These are not necessarily active within the agri-food sector itself. A lot of them are already increasing their efforts and reducing their emissions as much as possible. Often, inevitable emissions still remain and for these emissions companies are looking for alternatives to compensate. Through carbon farming, there are also opportunities to compensate and even to become climate positive, supporting local CF projects.

c. Models at farm level

Farmers can also take initiatives to market their products (through short chain or direct marketing to local shops and retailers) by using their carbon farming efforts in their communication, labelling, etc. as an extra incentive to attract new customers and to justify their (higher) product price. A classic and generally known example of such a business model is the 'organic' label.

d. Models including government institutions

We notice that a lot of municipalities, provinces, cities, etc. are developing climate action plans to compensate for their emissions. The application of CS techniques is therefore often actively promoted by government institutions. Two main strategies can be defined. First, when proven beneficial for the society and environment, governments can pay farmers directly for the ecosystem services they are providing as a consequence of their sustainable farming techniques. Second, systems where the government is intervening in carbon credit trading and the follow-up of the efforts by farmers in terms of carbon storage are another viable option. These systems allow farmers to design their own projects aiming at increasing carbon storage. Following approval of their project, farmers then receive carbon credits which they can sell to companies or organisations looking for alternative ways to compensate for their carbon emissions. In both cases governments would be promoting the implementation of sustainable CS techniques in modern farming.

Another interesting route to be explored for the future is the Common Agricultural Policy (CAP), that can create incentives for farmers, through legislation or funding, stimulating CS techniques. Policy will play a fundamental role in developing a fully sustainable agricultural sector that supports. environmental care and climate change action.

Business models for carbon farming

Reduce or compensate for CO2 emissions by storing carbon in the soil by applying soils management techniques at farmer's level.

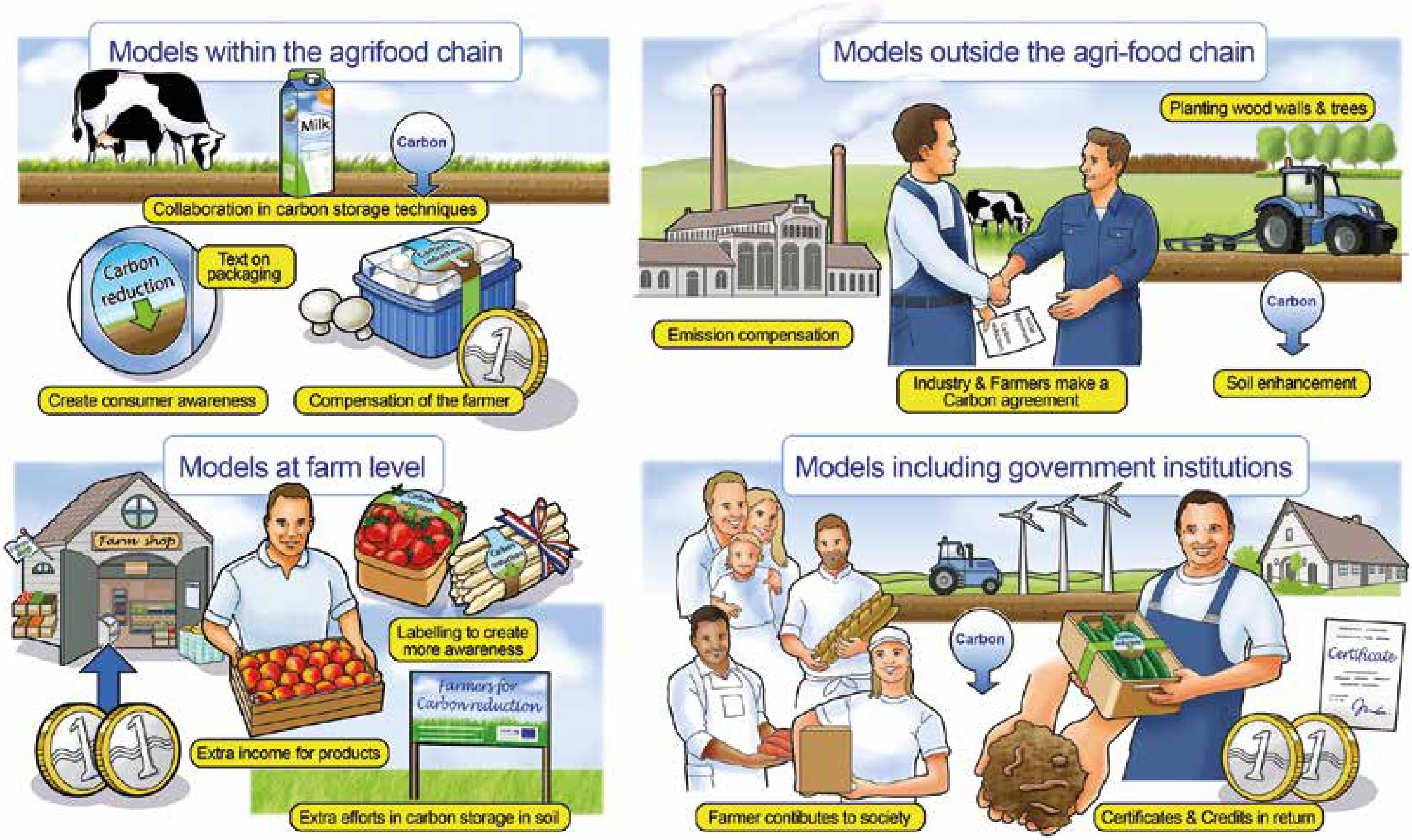


Figure 3: Infographic showing the four categories of business models identified by the CF project

Examples of the four business models generated by the CF project

The CF project is not the only pioneer in this area. There are other similar initiatives out there from which we can learn. Providing successful examples is a key factor in progress towards greening the NSR agrifood sector. In our report, Research of existing business models to valorise carbon sequestration, all lessons learned can be found. In what follows, per identified business model category, we put forward an example delivered or in development by the CF project.

a. Models within the agri-food chain

In the frame of the CF project, there are different routes explored and interest shown from different parties within the agri-food chain. In Belgium and the Netherlands, interest was shown from both farmers and retailers in the **beef chain**. While writing the white paper negotiations are still ongoing. On the one hand there are challenges encountered for an acceptable remuneration for the extra efforts by farmers. On the other hand there is the question of which monitoring system and suitable indicators to evaluate the amount of CO_2 captured in the soil.

Interest is also shown in the **potato and bread sector**. Farmers are hesitant to implement CS techniques, fearing that the extra efforts will soon be considered as the new normal, without proper remuneration.

b. Models outside the agri-food chain

In the near surroundings of Wind park Krammer (NL), **Zeeuwind, Deltawind** and farmers organisation ZLTO joined forces to take care of a unique and local way of carbon farming. A share of the wind park Krammer's profit is being invested to reduce CO_2 from the atmosphere for a long term sequestration in agricultural soil. Zeeuwind and Deltawind are working closely together with local farmers, mainly arable farmers, who sequester CO_2 in their soils. The farmers get 70% of the compensation paid each year according to their activities and 30% after conclusion of the pilot. The latter is based on the quantity of CO_2 that is being stored in total. Therefore, a baseline measurement as well as an end measurement takes place. In five year the amount of CO_2 sequestered can add up to 2.750 ton. In March 2021 ZLTO started a new project with the company DKG Keukens, situated in the region, buying 150 ton CO_2 which will be stored by 2 local farmers in the next five years, resulting in the company becomeing climate positive. The same conditions are applied here as in the Windpark Krammer pilot.

c. Models at farm level

Virgernes is a relatively small family driven farm in Norway with less than 30 hectares of land. Loss of soil and crops due to water erosion has had a great impact and made it difficult to live off such a small farm. The farmer has now changed his strategy regarding soil management to protect his soil from water erosion, enhance soil structure and fertility, enrich biodiversity and to sequestrate carbon. The use of CF-techniques give an additional income of approximately 25% in total due to the fact that end-consumers are prepared to pay more for sustainable produced food. CF techniques lead to higher total production and enriched soil fertility in the long run.

d. Models including government institutions

Ten farmers from the municipality of **Beernem** (BE) cooperate in a pilot project to sequester carbon in municipal territory. This is a way for the municipality to compensate for the emission of their municipal car fleet. This contributes to obtaining climate goals. Beernem signed their second major covenant for Climate and Energy, which amongst others has the goal of reducing CO_2 emissions. The monitoring and verification is based on data from international literature, adjusted to the regional situation through discussion with different scientific institutes.

3.3 Policy: Restrictions and opportunities for the local economy

The goal of the CF project was to focus on the knowledge and economic challenges in regard to implementing carbon farming. Meanwhile it has become clear that some policy changes are indispensable, yet within the time frame and focus of a project like CF, this was not feasible. Nonetheless, in section 4, we made some recommendations.

Based on the project's experience, we learned some interesting opportunities and recommendations for policy makers to become aware of when promoting local carbon offset and/or removal, and facilitating new collaborations;

By building possibilities in local compensation programs, policy kills two birds with one stone;

1. It avoids the channelling of money abroad
2. It adds to local climate mitigation and adaptation, as well as local food security, water buffering, increased biodiversity, landscape restoration, erosion control, etc.

We believe both local as well as abroad compensation programs should be possible, yet currently there are almost no compensation options on a local level.

In addition to economic motives and incentives, new collaborations can contribute to a higher appreciation of our local food production system. When setting up local collaborations, such as the CF show cases, and using this in communication with society, it could lead to increased knowledge, understanding and awareness at a societal level. Through these collaborations, we build, step by step, a higher connection between different parts of a society and a more connected community. On the one hand, farmers grow in confidence that they are perceived and appreciated as both food suppliers as well as deliverers of ecosystem services, on the other hand citizens grow trust in local supply chains. This also applies to companies, as they often offset their emissions abroad, mostly outside Europe. Companies are interested in local farm-generated carbon credits because in this way they are connected at the local level. Their employees can visit the farmers that generate the carbon credits used to offset emissions or become climate positive.

By strengthening local communities and supply chains, we create more local food security, local anchoring and jobs. It stimulates the local economy and benefits all.

4 Policy recommendations

Cover crop with Trifolium incarnatum and Phacelia tanacetifolia

This section contains the essence of this white paper, namely the policy recommendations the consortium of the CF project wants to address, based on the project's experience and results, as it was not in the project's scope to solve all challenges in regard to making CF the general new way of farming. There are still many actions left for policy makers to support carbon farmers and to create the necessary space for farmers and companies to take CF to the next level. In this last section we provide our recommendations to policy makers, both on European, national and regional level. As local and regional policy requires some specific attention points, we provided for The Netherlands, Norway and Flanders a regional addition, which can be found in the appendix. The recommendations are built upon the three cornerstones of this white paper defining the future success of CF, namely knowledge, economic feasibility and policy. Policy makers can stimulate CS by farmers in these ways:

- Overcome the knowledge barrier and focus on practical application of CS techniques
- Provide and support financial incentives through policy programmes and private markets. These two ways of economic incentives could, and probably should, be combined.
- Developing a holistic policy framework in which the different objectives (climate, biodiversity, water, ...) do not conflict with each other at farm level, but provide a clear and motivating framework for farmers. This is to avoid contradictory policy and administrative tangle for farmers. Even when finding an economically interesting revenue model, some current legislation will keep preventing farmers from participating in it.
- **Our most important and general recommendation would be to focus on how to motivate farmers and offer them a wide range of measures that can be practically integrated into their specific farm operations. Farmers fear that obligations will limit them in making CF tailor-made to their farm, as not all CS measures are fitted for all farms. Compulsory programs with limited flexibility would take away their creativity and motivation.**

4.1 Bridging the knowledge gap

Insufficient knowledge on how to improve carbon contents in soils is one important obstacle for farmers to start activities but also for policy makers to provide the appropriate framework for a greener agriculture with carbon farming. We noticed knowledge gaps can be expected in the complete range of perspectives carbon farming offers. At the project's end, the general questions mentioned below are left:

- Knowledge transfer: more knowledge among farmers on how to sequester carbon, how to contribute to their own benefit, how to see progress in the long and short term; exchange among farmers; independent advisors.
- More research on potential for CS for different measures and combinations of measures, different soils and climates, on forecasting and monitoring of CS and on validation to make sure that carbon is actually stored
- Better understanding on capacity and permanence of accumulated carbon in soils is needed (i.e. on "carbon binding")
- Extended knowledge and research is needed on appropriate CS measures and combination of measures for CS and to keep the new carbon level in soils while meeting the legal demands of fertilisation regulations.

Recommendations:

1 In order to be able to sell the service of carbon storage to third parties, there is a need for models and measurements as accurate as possible

All stakeholders (farmers, businesses, policy) need better systems to predict and monitor in the long term more specifically how much carbon can be stored under different management. The EU can support data collection and improvement of models, so they are better adapted to European and regional conditions. In addition to more accurate modelling and monitoring, further work on robust and suitable sampling and measurement procedures to follow SOC development in soil in combination with management data is also necessary.

2 For farmers, there is a need for practical understanding of the impact of carbon farming for their own farm and how they can monitor themselves practically how to see their soil improvement in the short term

(irrespective off the models and long-term measurements), e.g., soil structure, water retention, soil biodiversity, etc. Therefore, the CF consortium recommends to the European Commission to remain engaged in supporting practical research studies that develop local guidelines.

3 Facilitate tailor-made advice and support

Farmers receive advice from different, often supplier-related, commercial advisors and through the internet they can access all the needed information to start carbon farming. However, there is a general demand for advice and information tailored to their situation and support in navigating the overwhelming amount of information that is available. This advice and support can be offered by farm advisors and/or fellow farmers. Policy should guide the different processes by supporting independent advisors and advisory centres and special training.

4 Bridging the knowledge gap between research and farmers in both ways by continuing to support intermediary organisations and practice-oriented projects such as the CF project

Intermediary organisations, such as independent advisory services in connection to AKIS (agricultural knowledge innovation support systems) are relevant in bridging this gap, as well as practical research organisations. Bridging this gap will be a permanent challenge as knowledge and practical experience are continuously developing. Partnerships in which both research centres and advisors, as well as AKIS organisations are involved are playing a crucial role in bridging the gap. The CF partnership is a clear example of this recommendation.

5 Set up a long term monitoring network

Another important activity for policy is to support long-term soil monitoring activities to evaluate the development of soil quality and carbon contents. Here it is essential to combine soil analysis data with field management and site history data and to create consistent sampling, analytics and data collection. The results can be used to verify, develop and adapt modelling approaches, but on a more basic level the results should also mirror the activities of farmers and effects of policy programs of carbon farming activities in the long term.

6 Need for increased understanding, use and monitoring of natural nutrient flows and unwanted nutrient emissions of fertilisation systems

Real progress in SOC contents (high increase) is often seen as a potential risk for unwanted nutrient emissions only (e.g. N leaching, N2O emissions). On the other hand, with more organic matter in soils we create a natural source of nutrients, protect them from erosion and leaching and can replace mineral fertilisers. A better understanding of nutrient balances in agricultural systems, that are enhanced by natural carbon and nutrients and the consequent integration of the resulting nutrient pool in modern fertilisation systems, is necessary through more research.

4.2 Providing economic incentives

As outlined above we can conclude that farmers have to invest if they want to apply CS measures. These investments lead to benefits for farmers and for us as a society. Farmers therefore have to invest and incur costs today and repeat this annually, even though the benefits such as a sustainable productive yield and an increased resilience against extreme weather conditions only pay off in the long term and some of the measures entail more risks. A small group of pioneer farmers with a long-term vision of sustainable agriculture see these benefits and are already committed to them, often step by step to make investments feasible. We thank our learnings in the CF project mainly to these frontrunners who participate in the pilot projects that have been started within the framework of the project.

However, to encourage a large group of farmers to take CS measures, it is important that they receive rewards in the short term. This can be seen as compensation for costs incurred or as a reward for providing a climate service to parties who want to work on their climate goals on a voluntary basis.

To support the uptake of carbon farming practices by a large group of farmers, we want to make the following policy recommendations:

1 Set up a motivational framework in which different activities support each other:

- Farmers are willing to contribute to tackle climate change. It is therefore important to focus on motivating farmers through realistic compensation instead of obligations. Frontrunner farmers should not be excluded from future opportunities by the EU because they are taking actions now.
- Enable the possibility of blended funding of public remunerations (e.g., via the CAP) and rewards from the market in such a way that private funding will be optimally used. Governments could pay a basic price in order to guarantee a minimum compensation, which can be supplemented with rewards from the market. The condition of additionality must of course be taken into account.
- Emphasize the other benefits of CF such as improving biodiversity and resilience against climate extremes (improving water buffering) and translate this into compensation or reward.
- Focus on systems that allow **customization for farmers**, with a preference for a **result-based approach**, because this gives more flexibility to farmers to choose measures that fit their specific farm situation so that they can optimize their results. However, a result-based approach may disadvantage the frontrunners that have been active for a long time already with high SOC so we want to suggest a **hybrid system**: result-based in case of low SOC and action-based in case of high SOC.
- Do not wait with payments until results can be measured in higher SOC, but allow annual rewards for taking action already, because the result of carbon sequestration in the form of an increased OM content can only be measured after many years, while farmers have to make annual efforts for a long time.
- Minimize additional administrative burdens and look for control systems that do not require additional administration (such as remote sensing).
- carbon sequestration is a long-term process. Farmers therefore need long-term guidance and support for at least 20 years.
- Take into account that also soils that are already high in organic matter content need constant efforts to maintain this high level.

2 Ensure to reward the frontrunners in CF

According to strict international standards, only additional captured carbon that would not have been captured without the project is eligible for verification. A strict application of this criterion of additionality excludes frontrunners, even while they are very much needed to serve as an example for the large group of followers.

3 Support the development of a fair price for carbon sequestration by farmers

- Support research to create a better understanding of real costs and benefits for farmers, as well as for society, and what a fair price would be. It is important to prevent the reward for CS from entering an international race to the bottom, just as we do with food prices.
- At the moment, storing carbon in soils through CS techniques is still a long-term process with a rather uncertain outcome over time. The uncertainty of whether the predefined amount of carbon will actually be stored in the soil and in which time span can certainly play a role in farmers' hesitation. Therefore there is a need to define the remuneration ex-ante based on the applied carbon farming techniques and the region.

4 The agricultural sector will also have to deal with reduction targets in the climate agreement

In this regard we want to emphasize a motivational approach that ensures optimal implementation of carbon farming.

5 Support the development of the carbon removal market for farmers:

- Embrace and encourage private and local initiatives in the voluntary market, support these and make sure that these can be continued in a potential future official initiative.
- Support the development of reliable and affordable monitoring and verification of carbon farming. Potential buyers of farm generated carbon removal credits want the quality and environmental integrity of projects to be guaranteed, through certificates or standards. Agriculture in our region is much more intensive and smaller-scale than in the regions for which the current international standards to certify carbon farming (VCS, Gold Standard) have been developed. A translation is necessary to make them applicable in our regions, as well as financially feasible whilst maintaining reliability.
- Provide clear and independent information to farmers and buyers about carbon credit quality standards to ensure a reliable system.

4.3 Eliminating contradictory and restrictive policy

Currently the potential of carbon farming is not used to its fullest, in part due to contradictory and restrictive legislation, as explained in 'section 2.3. Contradictory and restrictive policy'.

In general, the perception is that obligatory and restrictive legislation is not working well in regard to building carbon content. We want to make a case of motivational policy that creates incentives and not restrictions.

1 Recognise the importance of carbon content in soils and show the willingness to increase this in the agricultural soils.

There are many ways for policy makers to do this. Policy adjustments or additional policies will be necessary in order to fully use the potential of CF that is now available.

2 Keep in mind to apply a holistic approach for carbon farming connecting different (environmental) policy goals

When working as a farmer it is clear that you work in a natural environment where everything is connected and interfering with each other. Increasing carbon content in soils influences the presence of other elements, such as nitrogen (N) and phosphor (P). In addition, the following parameters are influenced: water retention, water quality, (soil) biodiversity, GHG emissions, soil structure, etc. Currently there are many different (environmental) targets that were often developed without a holistic approach and thus neglect potential changes in other targets. We must prevent a one-sided approach to a carbon farming policy focusing only on CO_2 and increasing the SOC as quickly and as much as possible. On the one hand, this entails the risk that this cannot be easily implemented in all regions, e.g. in the agricultural regions with high production costs, such as a large part of the interreg NSR area. On the other hand, a one-sided approach can conflict with other objectives. An integrated approach must be aimed at achieving synergy and strengthening by optimally combining tasks in the field of CO_2, biodiversity and water, with a focus on practical feasibility.

In addition, it needs to be mentioned, that when policy makers decide to develop a framework for building carbon content it needs to bear in mind the feasibility in regard to other current policies in order to not conflict with one another.

3 Create a clear policy framework for farmers that leaves no one behind

4 Create the possibility for farmers to actually work on increasing the carbon content of their soils within a feasible and understandable administrative level

5 Find a balance between the ambition of carbon farming and the limits of the Nitrates Directive

Be aware that high SOC content can influence unwanted nutrient emissions. Therefore it needs to be mentioned to assess the water quality standards as a function of nitrogen and phosphorus, but also take into account carbon storage in the measures.

6 Future policy ambitions: motivational legislation

Throughout the last few years it has become clear that the European Commission acknowledges the importance of carbon content in the agricultural soils more and more. For example in the development of the new CAP, most probably through the eco-schemes, as well as within the Farm to Fork Strategy there are possibilities mentioned of a new EU carbon farming initiative under the Climate Pact.

The Carbon Farming consortium can only applaud those ambitions, yet we want to warn off additional obligations and suggest focusing on motivational legislation. The direct payments and market measures (first pillar) and the rural development (second pillar) can be built in a way to support carbon farming implementation.

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Appendix 1:
The Netherlands region

1. Motivation instead of obligation.

Farmers are eager to contribute. Therefore, focus should be on a motivating and integral framework in which different activities support each other and with a long-term perspective, instead of on obligations:

a. Focus on the long-term benefits for the farmer: carbon sequestration as a means for sustainable soil management, biodiversity, resilience against climate extremes and thus long-term sustainable production capacity
b. Measures must be practically applicable in business operations: result-oriented flexibility and customization instead of obligations
c. Provide an integrated approach to carbon farming: connect goals in the field of agriculture, biodiversity, landscape, water quantity and quality with long-term soil quality. And give farmers space to flexibly meet those goals.
d. Carbon farming is a long-term process. Supporting policy must therefore focus on a period of at least 20 years.
e. Frontrunners are important and should not be excluded from future support because they have already taken action.

2. Knowledge is an important tool:

a. Farmers need more practical knowledge: organize local knowledge groups of farmers who want to get started with carbon sequestration and that is in line with the region, soil, crop and type of farmers.
b. View of progress: give farmers tools and support to keep track of the progress and effectiveness of the measures.
c. Ensure that relevant knowledge available at knowledge institutions is translated into farming practice and that it also reaches farmers.
d. Knowledge development is needed. For example, more insight into how much carbon is captured with different measures and combinations of measures and the costs and benefits of the various measures.

3. Remove regulatory barriers and value the benefits of carbon sequestration when balancing different policy goals:

a. Support the production and application of good solid manure and compost. There is not enough good solid manure and incentives lack to use less chemical fertilizer. A firm switch to solid manure systems and limiting the use of chemical fertilizers can stimulate the production of good solid manure.
b. Ensure that the current policy for permanent grassland does not become restrictive.
c. Look at a stimulating legislation for land lease. Farmers need more certainty with their lease contracts. Short leases create uncertainty about the return on investment and thus limits a sustainable soil management.

4. Organize a motivational rewards system.

Farmers now have to incur costs and invest, while the benefits will only be visible in the longer term. In order to stimulate a large group of farmers, it is important that they receive compensation or reward in the short term.

a. Go for a real fee for carbon sequestration and stimulate blending of public fees (e.g. through the CAP) and rewards from the market. Governments could pay a basic price so that a minimum compensation is guaranteed, which can be supplemented with rewards from the market.
b. Rewards or compensation should not only be based on results, but also on the implementation of measures. The result of carbon sequestration in the form of an increased organic matter content can only be measured after many years, while the farmer has to make annual efforts for a long time.
c. With a high organic matter content, preservation of organic matter also requires considerable effort. It is important to take that into account in rewarding systems.

5. Support the development of the carbon removal market for farmers:

a. Embrace local initiatives in the voluntary market, support them and ensure that they can be continued under future policy.
b. Support the development of reliable, efficient and effective carbon farming monitoring and verification. Potential buyers of farm generated carbon credits want the quality and environmental integrity of projects to be guaranteed through certificates or standards. International standards that can certify carbon farming (VCS, Gold Standard) need to be translated to specific characteristics of our region in order to make

them applicable here. Agriculture in our region is much more intensive and smaller-scale than in the regions for which the current international standards have been developed. A translation is necessary to make them effective and financially feasible.

c. Provide good independent information to farmers and buyers about carbon credit quality standards to ensure a reliable system.

6. Support the development of a fair price for carbon sequestration by farmers.
Support research to give a better impression of costs and benefits for farmers and what a fair price would be. It is important to prevent the reward for carbon sequestration from entering an international race to the bottom, just as we do with food prices.

7. Data and administration: ensure that farmers are the owners of their (soil) data.
Data are a valuable asset for modelling carbon sequestration. Big agricultural companies investing in carbon farming are eager to get farmers' data. Make sure these remain in farmers' hands. Try to minimize additional administrative burdens and look for control systems that do not require additional administration (such as satellite photos).

Appendix 2:
Norway region

Whitepaper Regional Input - Norway
Background on policy and economy

Norwegian Agricultural Policy is based on the following principle with regards to sustainable agriculture decided in 2017;

Sustainable agriculture with lower emission of greenhouse gases (GHG)
- Reduce pollution and emissions of GHG, increase carbon sequestration and climate adaptation.
- Sustainable practices and strong protection of agricultural and other resource areas.
- Secure cultural landscape and biodiversity.
- Animal welfare.

A climate agreement was established in 2019 between the agricultural sector and Norwegian authorities. The parties undertook a commitment to reduce agriculture's total emissions of GHG by 5 million tons of CO_2 e.g. from 2021-2030.

The subsidies/income support provided by the Norwegian authorities give little stimulation to carbon sequestration practices. The national subsidies/income supports are geographically differentiated by area, the best areas for cultivation have significantly lower rates compared to areas with unfavorable climate. Another important fact is that 2/3 of Norway's agricultural area is grassland and not well adept arable land.

Norway also has regional subsidy schemes, so-called Regional Environmental Programs. These schemes are determined for each region, due to regional variations in challenges related to climate and environment. The grants for the region Viken - that may stimulate carbon sequestration practices- are given below.

Grants	Priority areas	Other areas
1) To prevent run-off		
No tillage in autumn, erosion risk class (1-4)*		
Class 1	250 NOK/Ha	150 NOK/Ha
Class 1 «with challenge»	850 NOK/Ha	600 NOK/Ha
Class 2	850 NOK/Ha	600 NOK/Ha
Class 2 «with challenge»	1500 NOK/Ha	850 NOK/Ha
Class 3	1500 NOK/Ha	850 NOK/Ha
Class 4	1600 NOK/Ha	950 NOK/Ha
Grass on areas prone to flooding and erosion	2000 NOK/Ha	0 NOK/Ha
No tillage on areas prone to flooding and/or areas close to streams, rivers or lakes	1100 NOK/Ha	
Directly sown autumn grain and autumn oil crops, erosion class 1-4	1700 NOK/Ha	0 NOK/Ha
Covercrops undersown	1100 NOK/Ha	85 NOK/Ha
Covercrops sown after harvest	1700 NOK/Ha	130 NOK/Ha
Grass-covered waterway	250 NOK/m	0 NOK/Ha
Grass stripes in fields	50 NOK/m	0 NOK/Ha
Grass-covered edge zone in fields	150 NOK/m	0 NOK/Ha
Waterponds for catching erosion and nutrition	8500 NOK/ha	8500 NOK/ha
** Erosion classes are determined by NIBIO based e.g. on soil mass and the slope of the ground.*		
2) To reduce emissions to air		
Deposition or closure of livestock manure	150 NOK/Ha	
Spreading of livestock manure with supply hose	500 NOK/Ha	
3) Environmental agreement		
Step 1 – dissolution of soil mass	2150 NOK/Ha	
Step 2 – spreading of compost, self-produced	4250 NOK/Ha	
Both step 1 and 2 have several requirements that must be met before grants can be awarded.		

Recommendations

Participation in the Carbon Farming (CF) project has given insight into what is happening in the other participating countries. We have tested cultivation and grazing methods, and methods for measuring changes of carbon in the soil. Based on the experiences we have gained through the (CF)project and the measures we have tried in Norway, we recommend the following:

1) Information and motivation

(NLR) now experience a large and increasing interest for sequestration of carbon in agricultural soil. Climate change is already affecting agriculture, and makes farming harder due to more heavy rainfalls, or drought. The results of the survey conducted by the CF project showed that the main reason why the Norwegian farmers do not use CF techniques is - insufficient knowledge.
We hereby refer to the recommendations made in Summary of the White Paper. NLR is and will be contributing to share the information CF techniques and to motivate the farmer to start using CF techniques adapted to the conditions on each farm.

2) Policy and economy

We recommend to focus on an overall goal to improve soil health by stimulating the farmers to use the broad range of CF cultivation and grazing techniques. An increase of SOC will have a positive ripple effect on the ecosystem, biological diversity in the soil and the agricultural landscape.

1. The most important measure for carbon sequestration in agricultural soil is **introduction of continuous green cover**, practically speaking undersown covercrops in grain and catch crops and diversity seed mixtures before or after vegetables, grain and potatoes or crops rotation with meadow. Several CF measures used together, specific for the area and the actual farm, will increase the outcome. The subsidy scheme for continuous green cover will have to be long-term, i.e. 5 or 10 years.
2. Further develop the current climate calculator to better include carbon sequestration in soil on farm level and the actual CO2 sequestered for each carbon farming technique.
3. Generate a national monitoring system of carbon sequestration in soil and soil health, as a follow-up to the current Soil Health Program (Nasjonalt program for jordhelse).
4. The current subsidies to prevent run-off in the low erosion zones are too low to cover the loss the farmer has with the crop in that singular year. In addition, these same measures also lead to increased carbon sequestration. We recommend that
   a. The subsidy must be increased.
   b. The subsidy text must be revised to state that the measures also lead to increased carbon sequestration in soil.

Appendix 3:
Flemish region

Challenges and recommendations for Flemish policy (english)

In addition to the bottlenecks that are a direct consequence of European regulations, the translation of European policy lines into Flemish legislation leads to concrete impediments to the carbon sequestration in agricultural soils in Flanders. We mainly highlight the Manure Directive, which is a Flemish translation of the European Nitrates Directive, and as well the problems concerning the status of permanent pasture resulting from the Common Agricultural Policy (CAP).

1. The challenges and bottlenecks of the Flemish translation of the Nitrates Directive

The Flemish translation of the European Nitrates Directive into the Manure Directive, impedes the carbon build-up of Flemish arable lands and pastures in other ways that are not or less applicable to the other member states. Of course, the importance of the Nitrates Directive and the Flemish Manure Directive should not be denied. The message we want to convey with this regional annex is to attach the necessary importance to carbon storage within, among others, the Manure Directive.

Within the framework of the Carbon Farming project, discussions were held with various Flemish farmers about carbon sequestration and the possibilities on their farms. There are quite a few farmers who have been aware of the importance of a good carbon content for a long time and who have already been actively working on it as much as possible. Unfortunately, we sometimes hear that the Manure Directive leads to situations such as these quotes: "I have used compost on my farm for 20 years, but was compelled to stop because of the new stricter manure legislation (MAP6 in Flanders)" and "The new guidelines on cover crops and reference areas, are acting as a barrier and are leading to the fact that I cannot experiment with new types of cover crops and learn from good examples from abroad. "

If the Flemish Government recognises the importance of carbon and wants to increase the carbon content in its agricultural soils, policy adjustments are necessary to fully use the potential that is now available. The most important and general recommendation that we want to put forward in this Flemish supplement is the following: **Assess the water quality standards in function of nitrogen and phosphorus, but also take carbon storage into account in the measures**.

We list below the most important stumbling blocks for Flemish farmers, as well as possible recommendations:

a. Fertilisation range is limited for animal manure

One of the biggest restrictions within the Manure Directive is that farmers in Flanders are allowed to apply a maximum of 170 kg N from livestock manure, because Flanders is categorised as a vulnerable water area. The only exception is derogation. In Flanders, this requires many controls and an administrative hassle for farmers, which makes companies give up or not even trying. If the farmer does go through the procedure, he can get an increase up to 250 kg N, only for grass, maize, winter wheat, triticale, beets and always under specific conditions.

As a farmer, you then quickly fall back on mineral fertilizers to meet the total nitrogen needs of your plants. Unfortunately, artificial fertilisers do not bring additional carbon to the land, whereas animal manure does. With a higher effect for stable manure compared to effluent and slurry, of course.

In addition, compared to other Member States, the Flemish translation of the manure legislation is even more restrictive for the use of organic manure due to the declining phosphate standards. When only the 170 kg/ha N from animal manure (or in case of extension through derogation 200 or 250 kg N/ha) is applied, a certain amount of animal manure can still be applied on Flemish parcels. Because of the stricter phosphate standards, the space for animal manure is further limited, especially for the types with higher phosphate content.

Policy Recommendation:

- Increasing the derogation. Research has already shown that the use of nitrogen from animal manure with a derogation for grass could be increased to 300 kg N/ha, without a significant effect on groundwater quality. Grass is also best managed with targeted fertilisation. In this way, policymakers make clear that carbon (and thus CO_2 storage) should also

be taken into account in addition to nitrogen and phosphorus.
Derogation could be put forward as a standard value for all derogation crops instead of an exception, see the Dutch CDM advice 'Assessment of derogation options'.

b. Fertilisation space is limited for stable manure

Within the Manure Directive, animal manure is broadly interpreted, which leads to the fact that also the straw in stable manure is seen as animal manure. However, a large fraction of stable manure consists of straw. Straw can contribute to a large extent to the carbon build-up of the soil, but because of this interpretation within the Manure Directive, the fertilisation space for stable manure is too limited.

Policy recommendations:

- Do not include the proportion of straw in farmyard manure as animal manure. Perhaps a regulation for N can be elaborated like for P in manure (only counts for 50% under specific conditions).
- Another option is to address on a European level for a separate statute for farmyard manure in order that more than the 170/250 kg N can be applied.

c. Digestate from fermenter fully counts as animal manure as soon as animal manure is co-digested

Within the Manure Directive animal manure is interpreted broadly, as a result of which digestate (one of the end products after fermentation) is labelled as animal manure. However, it can be said that digestate works almost like mineral fertilisers and can be better controlled than animal manure. This limitation means that artificial fertiliser is almost always needed to cover the needs of the crop. Digestate has a higher carbon content than mineral fertilisers, but due to the above it cannot replace mineral fertilisers when animal manure is also digested, neither for the non-animal part.

The Flemish Land Agency (VLM) states on its website that as a farmer you can ask for an exception through the objection procedure, whereby a (very) high carbon content can possibly be taken into account. Nevertheless, this requires a great deal of additional administration, whereby the request must be strongly substantiated and a soil analysis and fertilisation advice must be included, among other things. These additional requirements prevent many farmers from requesting an exception, to the detriment of good soil carbon content.

Policy Recommendation:

- One could opt to label digestate partially or completely as non-animal manure and allow it to be applied to equivalent guidelines as mineral fertilisers. Of course, provided that a system can be found that is not susceptible to fraud.
- We would also like to point out that the new European RENURE could be part of the solution. Our recommendation is therefore that Flemish policy-makers should put even more energy into this in the direction of Europe in order to get this implemented in the short term.

d. Nitrate residue is not corrected for soil organic matter content

Soils rich in carbon often have a higher nitrate residue due to mineralisation of organic matter. The fact that the Manure Directive does not correct for the soil organic matter content prevents many farmers from applying compost or other organic material to their soil.

If a farmer suffers from high residual nitrogen (often because the crop already has a risk), this will be an extra risk he/she will not dare to take. In short, a high carbon content, especially when the carbon is already stably fixed, will often lead to a risk of a nitrate residue. This means that policy makers expect the farmer to take various precautionary measures, such as additional catch crops, other crop choices, etc. to cope with mineralisation. As a result, a farmer will feel restricted in the choice of crops and rotation because of a high carbon content, which means that many farmers who have been busy building up carbon for years, by e.g. adding compost, will feel obliged to stop those soil measures and thus with a negative consequence for their carbon build-up.

Policy Recommendation:

- Here we would like to repeat our most important and general recommendation, i.e. also take into account carbon storage in the chosen measures to improve water quality. We would therefore like to advocate a correction for nitrate residue at higher carbon content.

e. Nitrate residue and restrictions on catch crops

The use of cover/catch crops has many advantages, but also involves extra costs and management. The main advantages of cover crops are: supply of organic material and improvement of the soil structure; prevention of N leaching and stimulation of N release in spring; erosion control; maintenance of the soil structure and prevention of compaction; weed control; control of diseases and pests.

Since 2019, new obligations regarding cover crops have entered into force in Flanders. The reason was the new Manure Action Plan 6 (MAP6), because the improvement of water quality was too slow and nitrate values were still too high. According to the VLM, the greatest short-term gains in water quality can be achieved by increasing the area of cover crops.

The policy and obligations with regard to catch crops are defined and strict. Sowing and harvest date, minimum cultivation period, type of catch crop, when to grow which crop, etc. There is a limited list of permitted cover crops. Many farmers, especially those who have already experimented with cover crops, encounter difficulties and limitations because of this new strict policy. For example, the sowing dates are strictly defined, even to the extent that if the weather is not favourable, you have to sow at a wrong timing (according to practice) to comply with policy (the theory). Knowing beforehand as a farmer that your seedlings will not grow well because of the weather. Moreover, the confidence of the farmers, who were already doing well, in policy makers has been infringed (again). The sown area of cover crops must increase annually. Therefore, a reference percentage per farmer will be allocated by the Mestbank based on the average share of cover crops and low-risk after crop, according to the 2016, 2017 and 2018 single applications. In other words, farmers who were already doing well in terms of applying cover crops are left disappointed, because the area of cover crops they had the year before was already high and will serve as their reference percentage and will therefore have to increase (when in area type 2 or 3). However, in determining this individualised percentage, the legislation has provided for some restrictions for farmers who, in the past, have sown many cover crops or very few cover crops. And this by stipulating that the reference percentage is at least 20% and the target area is limited to 80% of your arable land (in area types 2 and 3). Nevertheless, a negative aftertaste prevails among the more progressive carbon farmers.

We hear testimonies of farmers who state that the combination of "no tillage" with the limited list of allowed cover crops has become problematic. For example: "Phacelia is an expensive cover crop, but it is perfect to make a seedbed if you sow it as the only cover crop (not in a mixture). But since recently, you have to make a mixture between Phacelia and something that goes with it, like Japanese oats. "That way, I can't use 'non-inversion tillage' or 'reduced-inversion tillage', the advantages of Phacelia for a good seedbed are lost when combined with another." This statement needs to be nuanced somewhat, because if the farmer has sown sufficient acreage for CAP (where mixtures are obligatory), he could sow Phacelia solo. Nevertheless, this outlines how complex and challenging it sometimes becomes for motivated farmers.

Policy recommendations:

- Commit to the new cover crop regulation that no longer takes the past into account, but the crops that are sown in that year. Discussions between policy and agricultural organisations have started on this. It is important that sufficient sustainable practices per crop are proposed so that every company can apply at least one sustainable practice, easily within its operational management.
- Apart from grasses, leguminous plants are a prominent type of green cover that can deliver a lot of carbon. The Manure Directive does not allow leguminous plants to be part of a cover crop mixture. One of the components of a cover crop could also be a legume.

2. CAP

a. Permanent pasture

Permanent pasture is classified as any land covered with grass or other herbaceous forage for five consecutive years and which has not been subject to a rotation system or used as fallow land during the five-year period. It also includes land ploughed and sown again with grass. Permanent pasture has a high potential for carbon sequestration due to its extensive rooting system and the high turnover rate of crop residues. The preservation of these grasslands is therefore of great importance.

Since 2005, the CAP has applied obligations in relation to permanent pasture, namely the ratio of permanent pasture to agricultural land is set by the EU Member States at national or regional level (with a 5% flexibility margin). Thus, the CAP made the preservation of permanent pasture a condition for income support (cross-compliance). Europe requires that the area is maintained at Member State level as part of the greening measures of the CAP. Measures are imposed if the area of permanent pasture in a Member State decreases by more than 5% compared to the 2012 reference year.

In Flanders, this was immediately followed-up at individual level. In other words, farmers had to maintain their individual grassland area as a cross-compliance requirement of the CAP, an obligation known as the IRA (individual reference area). This status of permanent pasture, and certainly the IRA, had an undesired effect, namely that farmers had to tear up their grassland in order not to lose flexibility, each time the 5-year mark was reached. The acreage of permanent pasture declined after 2005 and after 2012.

To cope with this, in 2017 the Flemish government made some important adjustments in which way farmers have to comply with the European obligation to maintain the area of permanent pasture. Since then, not every farmer has to maintain his individual grassland area. It is therefore no longer an individual but a collective responsibility to avoid sanctions being imposed by Europe.

However, this has made little difference to date. In 2018, the decline was around 3%. Possible explanations for this are:

- Farmers still have a negative connotation of the term "permanent pasture" and lack confidence in the government that the permanent pasture status will not have negative consequences in the future. Many farmers we have worked with have expressed their fear of facing restrictions on the use of their permanent pasture. On cattle and dairy farms with some arable farming, grassland is often included in a crop rotation (a few years of grass, maize, cereals or other crops and then grass again), so a wider rotation can be achieved. For the above reasons, many still speculate about whether or not to tear their grassland.
- In addition to the risk of European sanctions, farms also face economic consequences. Farmers in a mainly arable area who are approaching retirement age and intend to sell, find that the sale price of arable land is much higher than that of permanent pasture. The decision is taken fairly quickly to tear up their permanent pasture in order to be able to sell at a better price.

Policy recommendation:

- It is clear that this issue is very complex. A solution could be to communicate better and more about the status of permanent pasture in order to eliminate unfounded misunderstandings.
- In addition, the Government could provide guarantees that this collective interest of preserving permanent pasture would not pose a problem of sanctions for individual farmers. In other words, we should not return to a 'stigmatisation' of permanent pasture with obligations at the individual farm level, because this is detrimental. An incentive-based policy (e.g. within eco-schemes or management agreements) is appropriate, which can be seen as an incentive for farmers to keep permanent pasture longer, as well as a compensation for costs and income foregone. Some of the concerns of farmers are not unfounded and, in the end, a farmer is an entrepreneur who has to make up his/her own math.

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