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Exploratory analysis of carbon farming systems in 9 countries on the European continent

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EJP SOIL Road4Schemes

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ILVO

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Report content

1. Objectives

This report is part of EJP Soil project Road4Schemes which aims to integrate research into the design and implementation of policy on carbon farming. The objectives of Road4Schemes were: **(1)** to assess the strengths and weaknesses of existing and planned schemes for carbon farming and additional Ecosystem Service (ESS) payments, including respective tools for Monitoring, Reporting and Verification (MRV); **(2)** assess stakeholders' perceptions and preferences with respect to strategies for scheme design and policy drivers and barriers; and **(3)** deliver a roadmap for developing and implementing context-based schemes for carbon farming and additional ESS payments. The Road4Schemes consortium comprised multiple EU member states such as Denmark, The Netherlands, Belgium, France, Germany, Austria, Czech Republic, and Italy, as well as Switzerland and Turkey. This deliverable is associated with work package 4: 'A roadmap for improving carbon farming schemes'.

In the context of this project, **carbon farming schemes** are defined as operational programs that aim to sequester carbon in the soil or avoid the release of GHG emissions from soils (supply) while compensating farmers or other land users for their efforts through a range of business models (demand).

In this report we zoom out from these operational carbon schemes to all possible incentives or actors that influence their functioning (European and regional policies, public opinion, agricultural education, measurement methods etc.). We refer to the dynamic interaction between carbon farming schemes, diverse stakeholders, and incentives within the social-ecological context as the **carbon farming system**. In all involved partner countries, various actors are working towards an operational carbon farming system that is able to effectively achieve targets such as climate change mitigation, adaptation, soil health, biodiversity conservation. Thus, rather than comparing the current carbon farming system, this report presents the results of a international analysis of the **development** towards effective carbon farming systems.

The main objective of this report is to provide starting points and a structure to allow the creation of individual roadmaps guiding different European countries towards implementing or discussing the implementation of effective carbon farming systems by:

- Identifying similarities and differences between countries regarding the various steps of effective carbon farming systems;

- Highlighting the potential for international learning *via* identification of pioneers regarding one or multiple steps of carbon farming systems in order to inspire other countries and regions in Europe.

2. Introduction

Carbon farming as a concept is undergoing rapid changes in how it is perceived and defined across countries and stakeholders. A popular definition in recent years has been that carbon farming consists of "farm management practices that aim to deliver climate mitigation in agriculture" (McDonald et al., 2021). Because the scope of this definition involves the entire farm, it considers both arable as well as livestock farming and refers to "all pools of carbon in soils, materials and vegetation, plus fluxes of carbon dioxide (CO_2) and methane (CH4), as well as nitrous oxide (N2O)" (European Commission et al., 2021). This holistic approach promotes the optimization of farm management for climate mitigation and need for emission reductions in all areas of agricultural production (e.g. from enteric fermentation, manure management, stable management, fertilization methods) as well as emissions from agricultural land use on cropland and grassland (see i.e.: Annys et al., 2022; McDonald et al., 2021). However, with its proposal for a carbon removal certification framework (CRCF[1]) in November 2022, the European Commission narrowed the definition of carbon farming to "a green business model that rewards land managers for taking up improved land management practices, resulting in the increase of carbon sequestration in living biomass, dead organic matter and soils by enhancing carbon capture and/or reducing the release of carbon into the atmosphere, in respect of ecological principles favourable to biodiversity and the natural capital overall" (European Commission, 2022; Kerstine Appunn, 2022).

Examples of improved land management practices as defined by the European Commission are afforestation, agroforestry, rewetting and restoring peatlands and improving carbon sequestration in mineral soils (European Commission, 2022). More specific examples for the latter include reduced or non-inversion tillage, cover crops (e.g. oilseed rape) and the maintenance of permanent grassland. The improved agricultural practices mentioned here are not new and often fall under the umbrella of agro-ecological practices, but are now also defined as carbon farming practices, because of the positive impact on carbon sequestration and avoided emissions (Annys et al., 2022). This interest in the mitigation potential of these practices encourages ways to remunerate farmers for the stored carbon (or avoided emissions) via carbon farming schemes which are: 'any voluntary agreements in which a farmer or a group of farmers commit themselves to apply carbon farming measures in return for a payment in any form' (Thorsøe, 2021). There are many examples of carbon farming schemes starting up on the European continent and in other parts of the world, of which some show better results than others considering their ability to achieve climate mitigation, climate adaptation, soil health or have high participation levels of farmers (Thorsøe, in preparation).

The essence of numerous ongoing research projects, policy initiatives, and collaborative working groups revolves around getting these kind of schemes to actually accomplish all their intended goals (see for instance EJP Soil Road4Schemes, C-farms, Expert Group Carbon Removals). This requires approaching the concept from multiple angles at once, such as how land users perceive carbon farming practices and schemes (Graversgaard, in preparation), as well as the incorporation of carbon farming schemes into national policymaking (Hönle, in preparation).

Complementary to such research, we propose a conceptual framework to structure and visualise these multiple angles of approach and how they might fit in the evolution of carbon farming systems. Such a framework has the potential to provide a broader perspective by examining the system-level dynamics, including the interplay between carbon farming schemes, a broad range of stakeholders, and incentives within the social-ecological context. It can further enable the

[1]CRCF - Carbon Removal Certification Framework - Brussels, 30.11.2022 COM(2022) 672 final 2022/0394 (COD)

structural comparison of various elements in the steps of carbon farming systems (often referred to as the 'steps' of these systems) and how they might evolve in complexity. For example, in some countries, there may exist forums for deliberation where stakeholders collectively determine the guiding principles of the carbon farming system. These principles could include decisions about which carbon farming practices to endorse and the permissible climate-related claims that financiers can make.

Additionally, we have performed an exploratory system analysis for each country in the Road4Schemes consortium, which takes stock of their regional carbon farming systems through a survey. This exploratory system analysis follows the structure of the conceptual framework we propose. The aim is to uncover inspiring and transferable ideas or identify areas where further knowledge is needed.

3. Methodology

We begin by outlining how we developed a conceptual framework which allows for an analysis of the development of carbon farming systems in multiple countries. This framework was constructed based on prior research on the possibilities for implementation and upscaling of a carbon farming system in Flanders, the northern region of Belgium, as part of the LIFE CarbonCounts project.

Following this, we introduce and provide detailed explanations of the five fundamental steps that constitute the road towards effective carbon farming systems. Subsequently, we shed light on how this conceptual framework was applied to survey results within the scope of work package 4 in the EJP Soil Road4Schemes project (further simply referred to as Road4Schemes project). Finally, we engage in a critical evaluation of the methodology employed to ensure accurate interpretation of the results.

3.1. Building a conceptual framework based on the Life CarbonCounts project

Prior to the international analysis within the Road4Schemes project, the authors were involved in another project regarding the design and implementation of regional carbon farming schemes: the Life CarbonCounts project. This particular project took place from the 1st of September 2021 until the 28th of February 2023 and focused on producing a system analysis and roadmap to help policy makers and other stakeholders understand, design and implement carbon farming in Flanders (Belgium) in a manner which meets their diverse requirements. The in-depth research on policy making for carbon farming and the resulting roadmap for carbon farming in Flanders inspired the current research within work package 4 of the Road4Schemes project by providing a conceptual framework (Figure 1). The framework has played a role in organizing the data gathered from prior work packages within the Road4Schemes project. This organization has enabled us to evaluate and draw comparisons regarding the progression of regional carbon farming systems.

The further course of this section clarifies how the conceptual framework for assessing the development of carbon farming systems has been established.

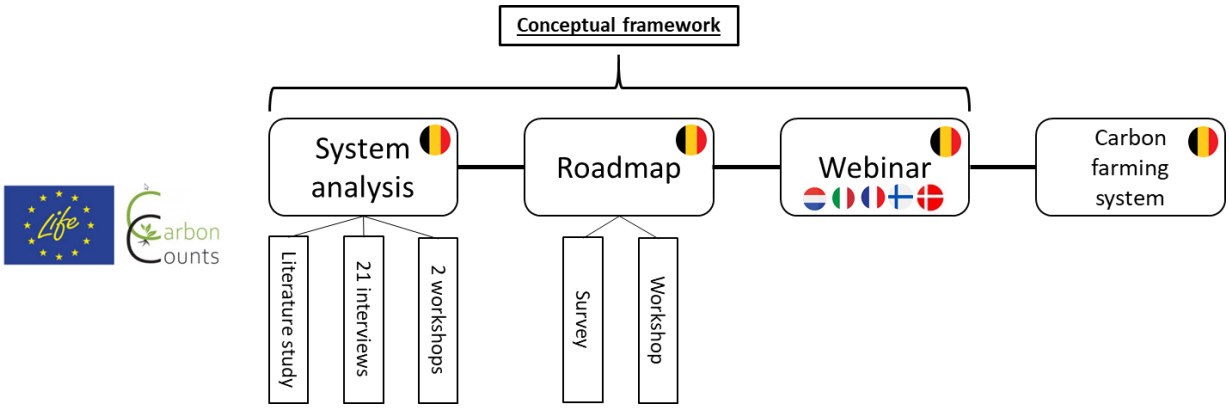


Figure 1: Schematic representation of the LIFE CarbonCounts project in Flanders (Belgium) that led to the conceptual framework used in the Road4Schemes WP4 exploratory system analysis.

The LIFE CarbonCounts project was led by the Department of Agriculture and Fisheries of the Flemish government and the Flanders Research Institute for Agriculture, Fisheries and Food (ILVO). The latter took the lead in a stakeholder analysis of carbon farming, including 21 in-depth interviews with stakeholders from various professional backgrounds, two workshops with policy stakeholders, and an extensive review of existing carbon farming schemes and business models in Belgium (e.g. Claire-CO2, Soil Capital), neighbouring countries (e.g. Label Bas Carbone, Stichting Nationale Koolstofmarkt, Woodland Carbon Code), and internationally (e.g. Verified Carbon Standard, Gold Standard).

In a first step, all of this data and knowledge was summarized in a system analysis of carbon farming schemes (see Annys et al. 2022). This systems analysis included the relevant policy context for carbon farming, the different carbon farming scheme designs and guiding principles, the available Monitoring, Reporting and Verification systems or MRV, different aspects of the carbon farming business model, and an overview of challenges and potential issues of carbon farming. A draft system analysis was sent to all interviewees in Flanders, who were invited to provide their input and reflections.

Secondly, the system analysis of carbon farming was presented to various audiences, including national and international researchers, practitioners, non-governmental organisations for agro-ecology, which resulted in a constructive dialogue on the approach to carbon farming. Through a survey and a workshop with the involved stakeholders, a roadmap to further enable carbon farming in Flanders was drafted (see Facq et al. 2023).

Thirdly, following the conclusion of the LIFE CarbonCounts project, ILVO organized an international webinar dedicated to carbon farming (recordings detailed in Gerits & Ruysschaert, 2023). During this webinar, the roadmap for carbon farming in Flanders was introduced to an international audience comprising experts, industry representatives, and stakeholders involved in the Flemish carbon farming ecosystem. In addition to the presentation of the Flanders carbon farming roadmap, ILVO extended invitations to carbon farming experts from Italy, Denmark, The Netherlands, Finland, and France. These experts were invited to provide insights into the carbon farming systems within their respective countries. In preparation for the presentations and panel discussions, ILVO conducted preliminary interviews with all five experts. This process aimed to ensure a cohesive and informative content delivery for the audience. As a result, these interviews contributed significantly to enhancing our understanding of the developmental trajectories of carbon farming systems in the respective countries.

All three phases of the research process in the LIFE CarbonCounts project, namely the system analysis, the development of a roadmap for Flanders, and the hosting of an international webinar on carbon farming, contributed to the creation of a conceptual framework for analyzing carbon farming systems across various countries. Through a combination of interviews, workshops, extensive literature review, and participation in international discussions, we identified a range of essential components necessary for constructing an effective carbon farming system. These components encompass aspects such as raising awareness among diverse stakeholders (including farmers and advisory services), establishing guiding principles related to additionality, long-term storage, and climate-related claims, designing governance structures, formulating policy support measures, creating viable business models, and implementing robust Monitoring, Reporting, and Verification (MRV) systems.

3.2. Conceptual framework to analyse the development of carbon farming systems

The conceptual framework consists of five steps that guide the way towards effective carbon farming systems (Figure 3). Improvement in all five steps is necessary and each step is indispensable for an effective and successful implementation of carbon farming. In the framework, certain steps are depicted sequentially, while others are portrayed in parallel. Additionally, some steps follow a one-way path, while others incorporate feedback loops. For instance, start-ups and piloting carbon farming schemes build on awareness from various stakeholders and necessary conditions provided by a supporting narrative, regulations, guiding principles and data-infrastructure. Feedback from these piloting carbon farming schemes could in their turn increase awareness and provide feedback to improve the necessary conditions.

In short, the trajectory towards fully-fledged carbon farming systems is not set in stone, yet there is a more or less common series of steps to take. The following sections introduce and explain each of the five step.

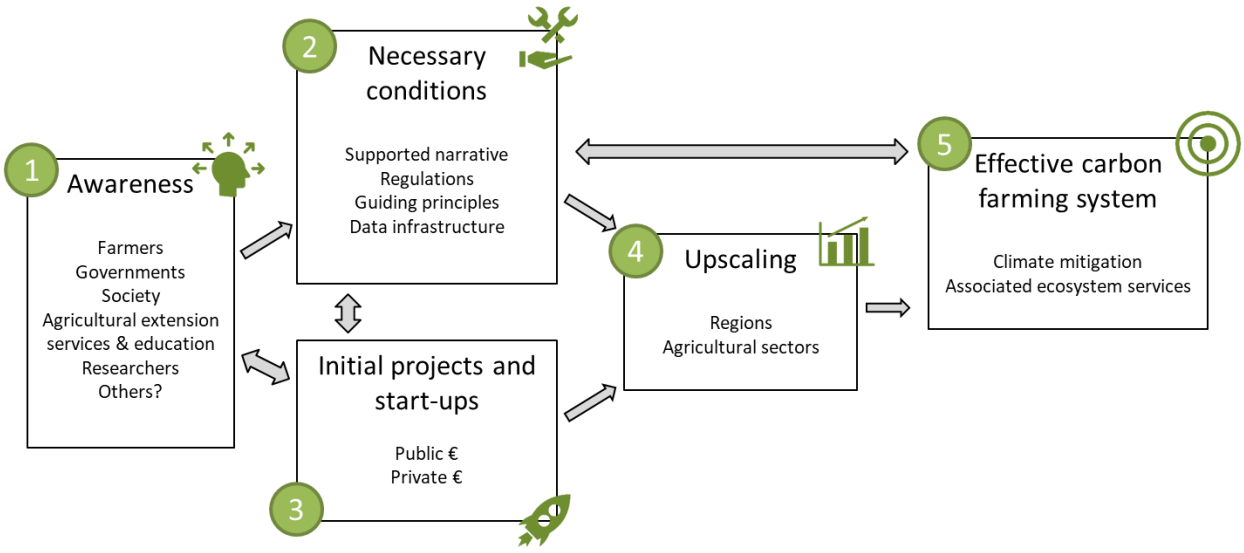


Figure 2: Conceptual framework for the exploratory analysis of developing carbon farming systems.

1. Awareness of carbon farming practices and business models

The awareness of different stakeholders regarding carbon farming practices and business models is a prerequisite for further steps in building carbon farming systems (Fig. 2). However, scientists have demonstrated that increased awareness of environmental issues, e.g. climate change, does not always lead to adapted behaviour (Torabi, 2019). In fact, there are many steps in the process between the awareness of an environmental challenge and actually taking action to create a positive environmental impact (Wi & Chang, 2019). We specify a multitude of stakeholders that should be made aware of carbon farming, including policy makers, farmers, professional or trade organisations, research bodies, management authorities, civil society, education, advisory services and researchers. Often the focus lies solely on policy makers and farmers as they are key stakeholders, yet the system analysis of the LIFE CarbonCounts project in Flanders highlights the influential role of other often overlooked stakeholders. For example, civil society organisations influence public opinion on carbon farming practices and business models. In Flanders, various groups contributed opinion pieces to mainstream media, and diverse organizations hosted critical seminars. These activities had an impact on gathering societal support which is deemed important for farmers to actually adopt agricultural practices and technologies relevant to carbon farming (Zheng et al., 2022) and more broadly, the wellbeing of farmers in the process (Deegan & Dunne, 2022).

Farmers as a key stakeholder group need relevant and reliable information to increase awareness of carbon farming practices (Dessart et al., 2019). This is where agricultural advisors and extension services appear as important stakeholders in the carbon farming system (D'Emden et al., 2008). Asides from knowledge about agri-environmental practices, awareness about the different related business models or financing schemes for these agri-environmental practices is an important factor influencing farmers' participation in agri-environmental schemes (Dessart et al., 2019; Pavlis et al., 2016). Knowledge about practices or business models could be different in areas and countries (Dessart, 2019), so it might be possible for this exploratory system analysis to highlight inspiring ideas from pioneering countries considering increasing awareness of carbon farming practices and business models among farmers.

Policy makers at different levels (EU, national, regional) are also important stakeholders in carbon farming systems and interact with each other. In many countries policy work on carbon farming started before the European Commission released its proposal on regulation for carbon removal certification (European Commission, 2022). The current situation of the carbon farming system within a member state or region might influence whether national or regional policy makers there apply a wait-and-see or pro-active attitude towards the upcoming EU regulation. In some countries carbon farming is still in a policy void and their policy process on carbon farming will be guided by the new regulation set by the European Commission. Other member states could choose to align their ongoing initiatives and local policies on carbon farming with the new regulation. For nations that have associations with the EU without being full members, the ongoing initiatives and discussions within the European Union can provide valuable inspiration for raising awareness among administrations and decision makers or how to initiate pilot programs.

For research organizations as actors in the carbon farming system it is important to continuously document new knowledge about carbon farming practices, associated business models and possible improvements in the development of carbon farming systems.

2. Necessary conditions for carbon farming systems

The formulation of policies related to carbon farming is integrated into a broader spectrum of environmental policies. Numerous carbon farming practices align with the ongoing efforts to promote a resilient and sustainable food production sector that operates within sustainable environmental limits, addressing environmental pressures, and actively contributing to agrobiodiversity preservation. Hence, this raises many questions about the position of carbon farming within the broader policy context. The development of carbon farming requires a clear, robust, inspiring and shared long-term vision on the purpose and goals of carbon farming, also known as a **carbon farming narrative**, in order to get farmers and farmer organizations to want to implement carbon farming practices. The narrative is equally required to provide sufficient legal certainty in the long-term, much needed for the build-up of soil organic stocks which requires the sustained implementation of carbon farming efforts.

Besides a strong narrative that is collectively supported, carbon farming requires clarity on guiding principles regarding key concepts, e.g. additionality and baselines. Field research has shown that all stakeholders are concerned about the risks of greenwashing through carbon farming systems. Greenwashing in carbon farming occurs when claims or calculations made on the climate- and environmental benefits of a carbon farming projects are not accurate or conservative enough and thus an exaggeration of the actual results obtained. This would create the illusion of effective action, whilst in actuality no progress is made. For example, a project might exaggerate the climate benefits it has achieved by not considering new emissions caused by the carbon farming practices or using overly optimistic values on carbon sequestration rates (calculation issue). A project might allow their certificates to be claimed as a (permanent) compensation of existing GHG emissions while the carbon sequestered could be re-released in a short time-frame (claim issue). The degree of greenwashing gets worse if both calculation and claim issues are combined. Although the risk of greenwashing is a serious and real problem in many environmental issues, it should not be positioned as an insurmountable barrier for the development of carbon farming systems but rather as an impetus to set out guiding principles. Additionally, it seems unfeasible to hold off on executing any carbon farming inititatives in order to first invent the 'perfect carbon farming system' where greenwashing and other risks are completely eliminated. Every region will have to gain at least some practical experience with carbon farming projects in order to optimize their systems over time (see step 3. Pilot projects and start-up carbon farming schemes).

In addition to the previously discussed need for establishing a governing structure to foster discussions on carbon farming narratives and guiding principles while mitigating greenwashing concerns, a significant impediment to the implementation of carbon farming initiatives lies in the absence of credible methods for measuring, reporting, and verifying (MRV systems) the outcomes of carbon sequestration practices (Smith et al., 2020). This challenge extends to the realm of national greenhouse gas (GHG) emissions reporting, carbon absorption and emissions trading. While several MRV systems have been developed (Beirinckx et al., 2023; Van Wijk et al., 2020), there is a pressing need to enhance their accuracy and precision, particularly at the requisite spatio-temporal scale. Additionally, the establishment of platforms or data infrastructure is essential to facilitate seamless data exchange between both public and private entities, thereby supporting cost-effective MRV systems. All such efforts must respect data ownership rights, as emphasized in Beirinckx et al (2023).

3. Pilot projects and start-up carbon farming schemes

In this step, pilot initiatives test the implementation and actual impact of carbon farming practices, as well as experiment with different ways to pay farmers for this type of ecosystem service. The pilot programs are characterized by relatively informal collaborations involving farmers, research institutions, and local entities such as municipal governments, non-governmental organizations, civil society groups, and retailers. Asides these pilot projects, there are also more developed start-ups that aim to professionalize carbon farming schemes as operational units where the sequestration of carbon (supply side) finds financial stakeholders to get remunerated for the carbon farming practices (Annys et al., 2022).

Due to the existing gaps in regulatory and governance frameworks in many countries, these pilot projects and start-ups operate under their own rules and guiding principles, which may not necessarily harmonize with what other stakeholders in the system would propose in a regional carbon farming strategy. This raises questions about how these initiatives will align with the forthcoming EU CRCF (European Commission, 2022). An inventory assessment (Thorsøe, in preparation) and a SWOT analysis evaluating the strengths, weaknesses, opportunities, and threats of a wide range of carbon farming schemes have been conducted as part of Work Package 2 within the Road4Schemes project.

4. Scaling carbon farming at a regional level

To harness the capacity of carbon sequestration in soil and both living and non-living biomass for outcomes such as climate change mitigation, adaptation, and enhanced soil health, we must move beyond initial pilot projects and emerging startups. It's imperative to expand carbon farming to a regional level. (Moore et al., 2015) delineated three scaling approaches: scaling up, scaling out, and scaling deep (as illustrated in Figure 3).

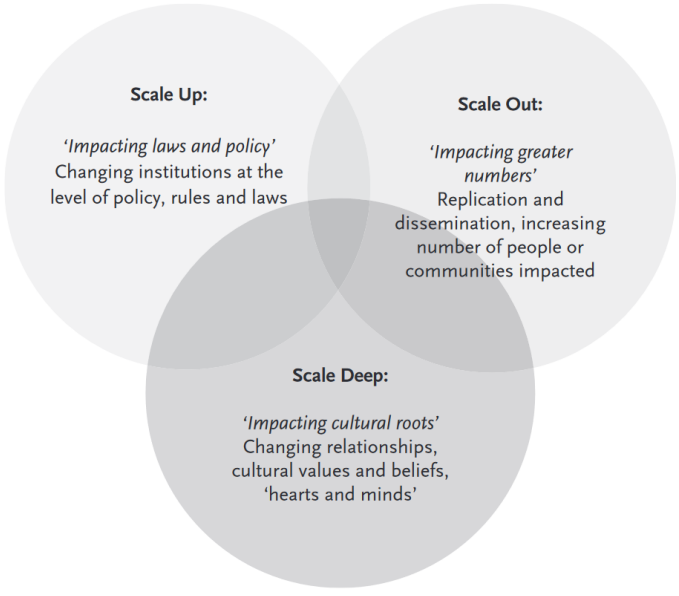


Figure 3: Different categories of scaling described by Moore et al (2015).

Scaling deep is about working on awareness and understanding of various stakeholders (building societal support, inclusion of carbon farming in agricultural education, ...), all concepts which are adressed in step 1 of the conceptual framework. Scaling up in the carbon farming systems is about creating governance structures, regulations and guiding principles as described in step 2..

Scaling out is what we aim for in step 3 and step 4 by increasing the adaptation of carbon farming practices and participation in associated business models across different locations and farming sectors. These scaling concepts are clearly not mutually exclusive, and to enable carbon farming a combination of these approaches to maximize their impact. In summary, scaling is a process which should be supported in the long term as carbon farming systems and the context in which they are implemented evolve.

5. Effective systems

By outlining the characteristics of an effective carbon farming system, we can ascertain if Road4Schemes partner countries are making progress toward achieving this goal. Numerous potential attributes can define effective systems, such as equitable sharing of costs, benefits, and risks among stakeholders in specific carbon farming initiatives, securing stable, long-term funding for land managers, crafting acceptable claims that satisfy all stakeholders, including critics in co-designing the carbon farming system, ensuring smooth dissemination of project outcomes to all relevant parties in Land Use, Land-Use Change, and Forestry (LULUCF), creating and recognising enhancements in soil health and biodiversity, and implementing a system that recognizes and rewards early adopters, among others. This is strongly linked to the governance structure where guiding principles are discussed among stakeholders (depicted by mutual interaction between step 2 and step 5 in Figure 2).

3.3. Data collection on carbon farming systems across the Road4Schemes partner regions

The previously proposed conceptual framework was used to draft a structured survey which was subsequently sent out to all Road4Schemes partners. The survey was divided into the five steps, and for each step both closed and open questions were formulated (see full survey in Annex I: Survey Task 4.2 (WP4 EJP Soil Road4Schemes)).

A first draft of the conceptual framework was presented in Vienna during the Road4Schemes partner meeting on the 28th of April 2023. Input of the various partners led to some adaptations to the conceptual framework and the accompanying survey. The research partners, experts in their domain, were asked to assess their regional situation and were free to contact other stakeholders, e.g. policy makers, in their own local network to supplement their answers as long as all answers were brought together in a singular file. As a result, some surveys were filled in by different carbon farming stakeholders, while other surveys received a response of 1 stakeholder. Moreover, respondents were stimulated to indicate if the local situation was unknown or too difficult to assess since this provided information on possible knowledge gaps. The experts who completed the survey were asked to review a draft of the report to check if their answers were correctly interpreted and reported.

We decided to refer to these completed surveys as an 'exploratory system analysis' of each partner region. Their role in the fourth work package of the Road4Schemes project is to provide a holistic view over the carbon farming system and synthesize data gathered in the previous work packages. Therefore, the experts were asked to draw from data from the scheme inventories (WP2, Figure 4), expert and policy surveys (WP3.1, Figure 4) and national workshops and focus groups (WP3.2, Fig. 2) where possible but to add new information where relevant.

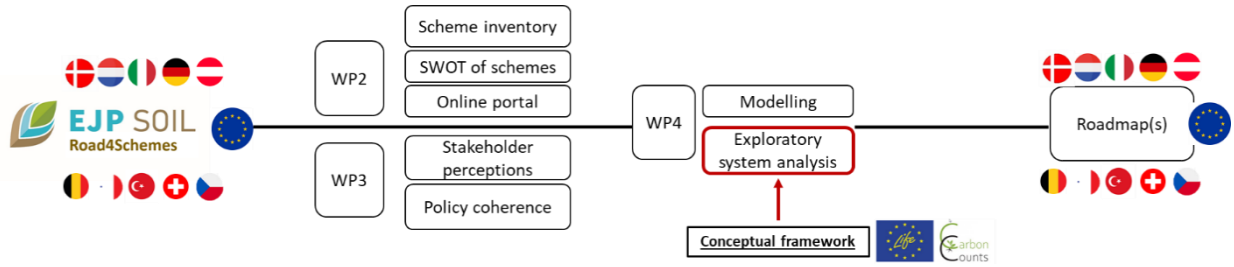


Figure 4: Schematic representation of the EJP Soil Road4Schemes project with an indication that the conceptual framework from the LIFE CarbonCounts project in Flanders was brought in WP4 for a international exploratory system analysis.

3.4. Critical reflection on methodology

It's important to take into account the limitations of the research presented in this report in order to accurately interpret the findings.

The responses provided by the Road4Schemes partners who participated in the survey may not necessarily reflect the viewpoints of other stakeholders within the regional carbon farming system. The perception of the carbon farming system is influenced by the individual or individuals responding to the survey, their particular expertise (whether in economics, social aspects, technical aspects, etc.), and the effort invested in completing the survey. When interpreting the results, it's essential to recognize that these findings predominantly represent one perspective, and it remains uncertain whether this perspective accurately represents the entire regional carbon farming system.

The level of awareness reported by various actors within the carbon farming system (as illustrated in Step 1 of Figure 2) is contingent upon the approach employed by the participating Road4Schemes partner(s) to conduct the assessment. Some Road4Schemes partners derived their responses from focus groups or workshops carried out in an earlier phase of the Road4Schemes project (as shown in WP3.2 in Figure 4). Meanwhile, other Road4Schemes partners referenced regional studies conducted in their areas to gauge farmers' awareness of carbon farming practices or sustainable soil practices. It's important to acknowledge that both the work conducted in WP3.2 and other regional studies may have their own limitations, such as potential biases in respondents or participants. To provide a specific example, the open invitation for participants in WP3.2 may have attracted primarily those farmers with a pre-existing interest in carbon farming practices or associated business models.

The exploratory system analysis presented in this report offers a snapshot of the present state, which is currently undergoing significant changes. Rather than concentrating on designing perfect carbon farming systems, the report emphasizes the system's development process and the exchange of structural knowledge. This approach ensures the report's continued relevance in the midst of the ongoing dynamic changes. By doing so, we aim to minimize the risk of the information in this report quickly becoming obsolete.

4. Results

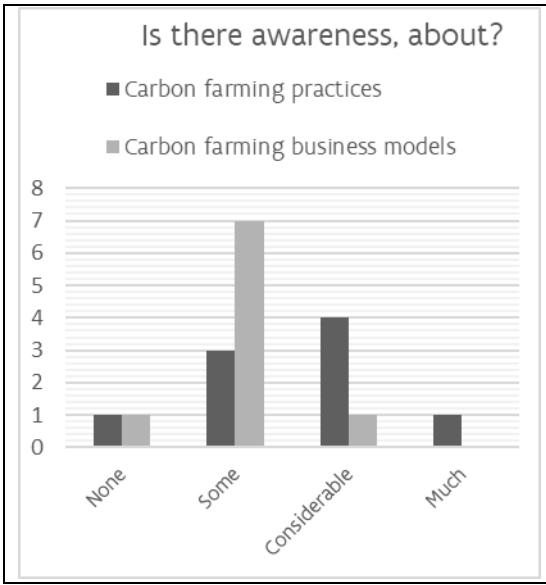
The results section is structured by step and combines data for all countries in a comparative international analysis of differences and similarities in the process towards effective carbon farming systems.

4.1. Awareness about carbon farming of different stakeholders in the carbon farming system

For the international exploratory system analysis we questioned the Road4Schemes experts about awareness of different stakeholder types that were identified in the LIFE CarbonCounts project in Flanders (Belgium): farmers, civil society organizations, farm advisors and education systems, policy makers, stakeholders in the voluntary carbon market, researchers. As there might be other relevant stakeholders in other countries, we asked the experts to indicate possible other relevant stakeholders as well.

4.1.1. Farmers' awareness about carbon farming practices and business opportunities

Q: To your opinion, is there awareness among farmers that certain practices (e.g. rewetting grasslands) are influencing carbon sequestration and about carbon farming as business model?



According to the experts, farmers are considerably more aware of carbon farming practices than related business models. Experts from Turkey indicated that awareness is "only in the early stages" (none was indicated), as it is mainly in the light of export contracts for Turkish products to EU buyers.

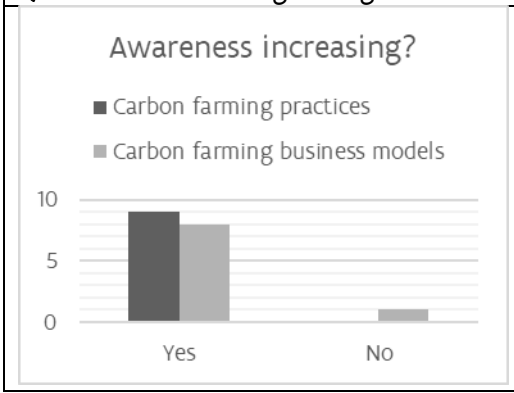
Illustrative quotes:

"All participants (of the focus groups [note authors]) knew of certain carbon farming-field practices and practised them already to varying degrees." ***[DK] [IT]***

"Arable farms in conventional systems are encouraged to use cover crops for soil conservation by many measures under the CAP, …" ***[CZ]***

"Many farmers in Flanders know that carbon in the soil is beneficial for soil health, and how they could increase soil carbon (mainly by cover crops, crop rotation, application of organic manure)." ***[BE]***

Q: Is this awareness growing?



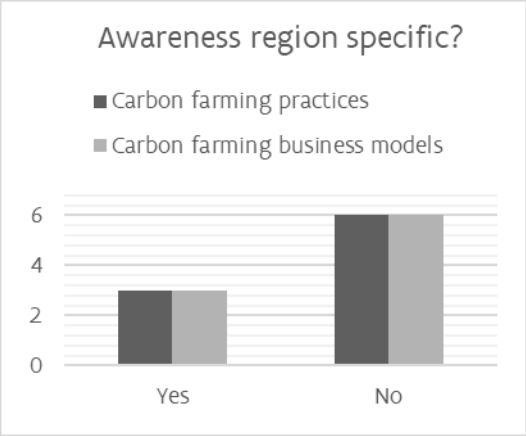
The experts unanimously agree that carbon farming practices and associated business models (except for Turkey) are a key topic gaining momentum.

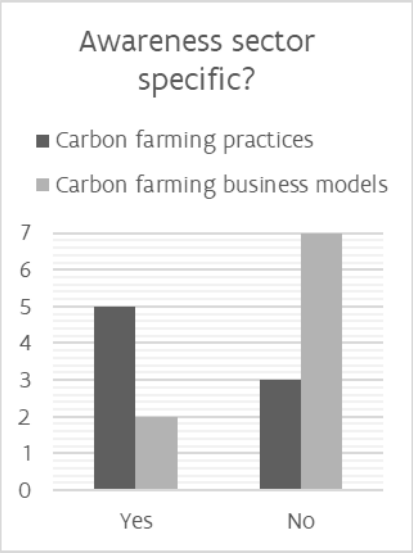
Illustrative quotes:

"The public debate and promotion of carbon farming e.g. by the farmer unions in the last years definitely raised awareness on the issue." ***[DE]***

"Recently, there has been a lot of attention in farmers' magazines about the potential of carbon farming …" ***[NL]***

"Many times in professional news channels last few years." ***[BE]***

Q: Is this awareness region-specific?	
	Except for France, the Netherlands and Austria, experts indicate awareness not to be region specific for both carbon farming practices and associated business models. **Illustrative quotes:** *"In a German wide project (…) farms all over Germany have applied to assess carbon farming practices."* ***[DE]*** *"Some regions and sectors are more advanced in the communication on and involvement in carbon farming."* ***[FR]*** *"Recently, there has been a lot of attention in farmer's magazines the potential of carbon farming and about the threat that grassland on peat will need to be rewetted to reduce CO2-emissions of such fields."* ***[NL]***

Q: Is this awareness specific for farming sectors (livestock, arable, mixed)?	
	Experts indicate that awareness of carbon farming practices is more often sector specific than the associated business models. **Illustrative quotes:** *"Much, attention to regions for rewetting peatlands, but it appeared that both dairy and arable farmers know already a lot about carbon farming practices, at least those that participated in the workshops."* ***[NL]*** *"Arable farms in conventional systems are encouraged to use cover crops for soil conservation …"* ***[CZ]*** *"The livestock sector (via IDELE) was also ahead of the game in developing the tool for estimating GHG reductions: CAP'2ER, which was available as soon as the low-carbon label (LBC)came out."* ***[FR]*** *"The topic is affecting different farm types but with different focus (e.g. livestock rather for grassland options such as climate neutral milk production; arable rather with catch crops and agroforestry)."* ***[DE]*** *"The interest is higher in the livestock sector because C farming (fodder cultivation in rotation with cereals, catch crops, and sustainable grassland management) is seen as a way to reduce the unavoidable emissions from the sector."* ***[IT]***

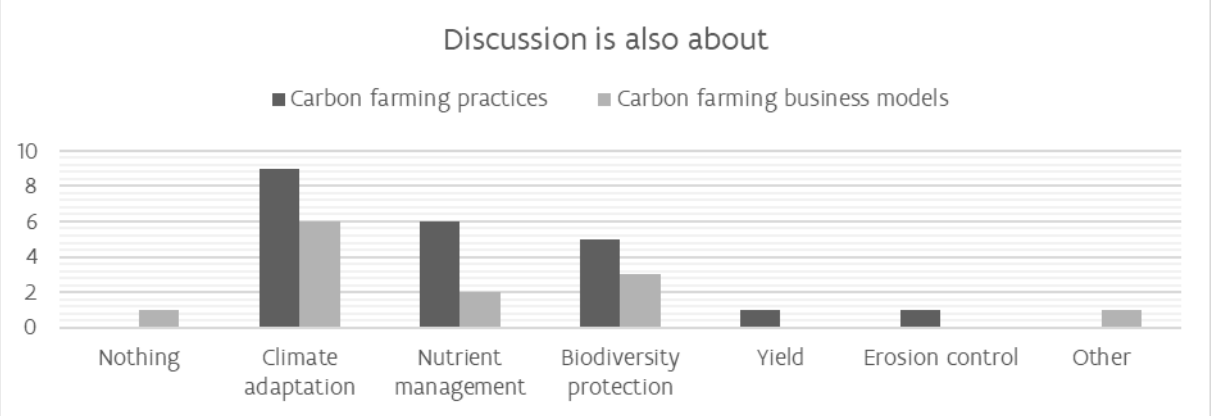
These findings align well with our previous work focus on carbon farming in Flanders (Annys et al., 2022; Facq et al., 2023) which found that carbon farming practices are often well known and applied by farmers. However, several new business models are appearing to remunerate and promote these carbon farming practices for the same or different purposes (soil health, climate mitigation, climate adaptation, biodiversity, etc.). The apparent discrepancy between awareness of agricultural practices recognised as carbon farming and the associated business models may be partly due to a certain scepticism of land managers.

In general, all involved countries can benefit from raising farmers' awareness about carbon farming business opportunities. Clear, well-functioning examples of carbon farming programmes and a convincing, supported narrative are lacking and the resulting vagueness is more likely to scatter interested land managers. Apart from France, the Netherlands and Austria, where there are regional variations in the knowledge on carbon farming, the need to increase awareness on carbon farming is a ubiquitous challenge, yet, some specific sectors (e.g. livestock farming) might

need more attention than others (e.g. arable farming). We recommend to make a sector-specific evaluation of the carbon farming system: Does carbon farming provide opportunities for all agricultural sectors? It is likely that not all agricultural sectors will have even opportunities to participate in what carbon farming system might eventually become. For instance, greenhouse farming is not likely to sequester additional carbon in mineral soils. Yet, some of the principles of carbon farming might be transferable to these sectors.

Continuing on the theme of awareness, it is observed that some advantages of carbon farming systems (besides climate mitigation) are emphasised more than others by regional stakeholders in order to reach and activate farmers.

Q: Is the local discussion about carbon farming practices or business models linked with related agri-environmental issues like climate adaptation, nutrient management or biodiversity protection (co-benefits/associated ecosystem services)?



Across all (9/9) countries the experts indicate that, besides climate mitigation, the discussion about carbon farming practices also addresses topics on climate adaptation, and to a lesser extent (6/9) nutrient management, biodiversity protection (5/9), yield and erosion control (1/9).

The survey furthermore questioned what would be an appropriate message or narrative to promote carbon farming practices to farmers.

Q: To your opinion, do you think that it is better in your country to promote farming practices for climate adaptation, soil health and biodiversity with climate mitigation as co-benefit, or the other way around?

All but one involved partner countries (8/9) indicated that soil measures to improve soil health and climate adaptation should be the main message for farmers. Experts highlight the intangibility of climate mitigation, referring to the global scale of climate change or the long-term horizon. Meanwhile, they clarify that climate adaptation and soil health are much nearer to a farmer's daily practice. It appears that a significant regional benefit always comes across more strongly than a limited contribution to solving a global problem.

Illustrative quotes:

"Many farmers are not aware of their own farm's contribution to climate change. On the other side, many farmers see benefits from climate adaptation, soil health and biodiversity." ***[NL]***

*"Farmers' motivation greater with focus on soil health -> as it benefits them directly as well. "****[AT]***

"You have to show that is it beneficial for the farmer: optimizing inputs, increasing competitiveness, and the economic sustainability of the farm and the farming activities. Awareness of climate change impacts is hard as, in the good years, farmers are quite short-sighted and tend to forget quickly the bad years and focus on short-term revenues and profitability." ***[FR]***

"Due to the high impact of climate change in Italy, with severe droughts periods followed by extreme weather events such as floodings, we believe that Italy should focus primarily on climate change mitigation and soil protection" ***[IT]***

"Denmark (yet) isn't affected by climate change in the same scale as other countries. Therefore climate mitigation as an ultimate goal, still seem a bit abstract for some, whereas soil health and biodiversity is more easily recognizable." ***[DK]***

"Maybe more interest for soil health, resilience, nutrient management – because there are many issues ongoing for farmers who need to reduce the N and P pressure on the surroundings. Also drought and excess water is an important concern where SOC and soil health can improve resilience of the agricultural sector." ***[BE]***

Motivations for carbon farming appear to be different depending on, for instance, countries geographical location, political and sectoral structure. This implies that it is useful to adapt the narrative about carbon farming to the national and regional situation. Experts from Italy and Turkey, for instance, mention that they experience severe effects of climate change which urges the need for action in the farming community. Meanwhile in Denmark the experts mention that they are relatively less impacted at this time. When farmers experience the impact of climate change we would expect that could motivate taking action for both climate mitigation and adaptation goals. Maybe more for the latter since this is beneficial on short term. Challenges such as climate adaptation and soil health are much closer to the farm level and the farming practices. Thus, they provide a better entry point to start the discussion on carbon farming practices than the climate mitigation. Yet practices should benefit both.

4.1.2. Civil society's interests in the carbon farming system

In support of the carbon farming practices it is relevant to assess the interest of civil society organizations which could support the carbon farming system.

Q: To your opinion, is there awareness among civil society organisations about carbon farming as business model? Were there civil society organizations actively involved in debates about national/regional carbon farming systems?

It appears that in 8/9 countries, civil society organizations are aware of the carbon farming system, and in 6 countries they are also involved in the debate about carbon farming. From the qualitative analysis of the survey it appears that civil society organizations can play different roles for the carbon farming system (supportive, interested, concerned or critical/sceptic).

Supportive	Interested
Initiator for peat protection **[NL]** Environmental NGO helps to test and pilot a result-based scheme for biodiversity **[CZ]** Financial support for schemes **[FR]** Involved in agroforestry consortium with attention for carbon farming to remunerate farmers **[BE]**	Might be interesting new method to help mitigate climate issues in agriculture and provide additional income to farmers **[DK]** Chance for small, mixed, and/or organic farmers to be remunerated for efforts **[FR]** Potential with its pros and cons recognized **[AT]**
Concerned	**Critical, sceptic**
Not about carbon farming, but concerned about climate change **[TU]** Questioning who ends up with the gains of the business model **[BE]**	Greenwashing, long-term storage, additionality, first mover disadvantage and selective perspective on climate mitigation **[BE, DE, FR]**. Critical for the voluntary carbon market **[AT]**

Civil society organisations in most countries are aware of the importance of carbon farming systems. However, in some countries, they are not involved (enough) in the debate or are not sufficiently aware of ongoing discussions on the principles of the system. It is important to engage constructively with critical civil society since we know that this impacts the farmer sentiment, which is in its turn key to scale carbon farming systems. Overall civil society organizations raise similar and valid concerns across different countries, and by being involved in the discussion, they can play an active role in supporting and implementing a positive narrative on the carbon farming system. In addition, discussions on the role carbon farming should play towards reaching various goals (e.g. climate mitigation, biodiversity enhancements, farmer profitability, …) might clarify the concept through practical consensus. This pragmatic approach might help get past the confusion which often occurs when positioning carbon farming in relation to concepts such as agro-ecology, regenerative farming, climate farming, etc.

4.1.3. Agricultural extension services and agricultural education in the carbon farming system

To increase the awareness among farmers and farm advisors, inclusion of carbon farming topics in agricultural education and extension services is important to support the carbon farming system. Especially to inform stakeholders about business models associated with carbon farming practices.

Q: Are carbon farming practices and/or business models included in agricultural education?

Except for Turkey, experts of other partner countries indicate that carbon farming practices and or associated business models are included in agricultural education.

Yet, the way this education is organized is different and often not structurally but rather ad hoc **[FR, DK, BE]**: "*Some guest lectures, internship projects, bachelor, MSc and PhD theses at universities. Rather ad hoc and not structurally incorporated*" ***[BE]***. Differences seem to exist in terms of when and for which students the topic of carbon farming is introduced. In the Czech Republic, carbon farming is marginally included in agro-ecology courses within University curricula. In France, there are collaborative efforts involving research institutes, universities, and secondary schools. In Flanders (Belgium), aside from occasional inclusions in higher education, some secondary educational consortia reference carbon farming in their curricula, although it remains uncertain how teachers present this topic in the classroom.

Often, agricultural practices in support for soil health [DE, IT] or agro-ecological transition [FR] are taught but these practices are not specifically framed as a carbon farming practice, and there is fewer attention for associated business models. An inspiring idea from the Netherlands is to develop teaching materials in secondary schools regarding carbon farming which focus on the broad range of potential benefits for the land manager.

The programme 'Slim Landgebruik' ('Smart land use', focused on carbon farming) developed learning materials and tools that can be used in agricultural education. They developed teaching materials for both secondary and higher professional education. On the website it is described that this teaching material is developed to make future entrepreneurs 'aware about the usefulness and necessity of carbon sequestration in soils' and increase the application of carbon farming measures on their future farms to reach carbon reduction targets. The teaching material has a broad focus with equal attention for additional soil related ecosystem services, asides climate mitigation. Teachers can access the educative material on an online platform and implement it in their courses as they see fit. Asides the comprehensive and contemporary information about carbon farming a serious game is developed (Soil Simulator), where students make decisions about soil management on an arable farm on clay soils.

Bij de les met bodem en klimaat | Slim Landgebruik

Q: Are carbon farming opportunities included in public or private agricultural advisory services?

Identical to education, except for Turkey, public and private extension services in all participating countries include carbon farming as a theme in their services to farmers. Yet, the French experts indicate that carbon farming as a topic in extension services is rather new and often specific expertise of intermediaries is called in: *"However it is also quite new for advisors and quite hard for everybody to follow the regulation and to cope with how standards and certification etc. work. Hence the use of intermediaries like AgroSolutions, FranceCarbonAgri etc."* ***[FR]***. Because of the highly dynamic process developing the carbon farming system (upcoming regulations, improved models, remote sensing etc.) regular updates and refreshing of knowledge are needed to avoid outdated advise. An inspiring idea from the Czech Republic is that academics working on the cutting edge of the carbon farming system are invited to disseminate information to both private and public advisory services.

In the Czech Republic the national advisory coordinator invited academics to disseminate information about carbon farming (debate, issues, priorities) to private advisors and advisory chambers. Doing so, the most recent insights from research are provided to the agricultural extension services.

4.1.4. Policy makers' interests from different domains in the carbon farming system

Q: Which policy domains show interest in carbon farming? Are these domains aware of the potential of carbon farming practices? What do these policy domains expect primarily from carbon farming practices?

Table 1: For different policy domains (agriculture, environment, climate, energy), the interest of ministries or government departments in carbon farming is indicated. If the expert indicated having found information on carbon farming on the website, the indication is in black (X), otherwise in grey (X). In the questionnaire, three items were possible for relevant policy domains. Only Germany (DE), France (FR), the Netherlands (NL), Austria (AT) and Turkey (TU) completed three domains. If indicated with asterisks, further explanation of the policy domain was required.

	Main expectations from carbon farming					
Policy makers within the domain of Agriculture	Mitigation	Adaptation	Nutrients	Biodiversity	Soil health	Other
Germany	X	X	X	X	X	
France	X					
Czech Republic	X	X		X	X	
Italy	X	X	X			
Denmark	X	X	X			
Belgium	X	X			X	
Netherlands	X		X		X	?
Austria	X	X	X	X		
Turkey		X	X	X		

Policy makers within the domain of Environment/ Climate/Energy	Mitigation	Adaptation	Nutrients	Biodiversity	Soil health	Other
Germany	X	X	X	X	X	
France*	X					
Czech Republic	X	X		X	X	
Italy	X	X	X	X		
Denmark						
Belgium	X	X	X	X	X	Erosion
Netherlands	X					
Austria	X	X				
Turkey **	X					

* *Ecological and energy transition*
** *Trade*

Various	Mitigation	Adaptation	Nutrients	Biodiversity	Soil health	Other
Germany*	X					
France **	X	X				
Netherlands***	X					?
Austria****	X	X				
Turkey*****						

* *Economy and climate*
** *Agency for ecological transition (ADAME)*
*** *Circularity*
**** *Austrian Panel on Climate Change*
***** *Environment*

According to the experts, all **agricultural ministries** (except for Turkey) set out climate mitigation as objective for the carbon farming system. In France, the questioned experts at Road4Schemes noted that carbon farming is primarily linked to mitigation on dedicated web pages, but this

doesn't imply that they disregard the other advantages it offers. In Germany it was also mentioned that policy makers are currently discussing their position towards carbon farming. The German ministry of economy and climate are interested in developing sound rules for carbon removals. The co-objectives of carbon farming according to agricultural ministries are climate adaptation and nutrient management, and to a much lesser extent biodiversity and soil health.

In many Road4Schemes partner countries the policy **departments of environment**, sometimes in combination with **climate** and or **energy** also shows an interest in carbon farming. These policy domains are interested in the potential of carbon farming to contribute to climate mitigation (except for Denmark). In France, the Netherlands and Turkey this is the main interest, whilst in Germany, Belgium and Italy there are also main interests in climate adaptation, nutrient management, biodiversity conservation and soil health and erosion.

4.1.5. Stakeholders in business models associated to carbon farming practices (e.g. Voluntary Carbon Market)

There are different forms of business models associated to carbon farming practices which differ in how they are organized, what the purpose of the business model is, who the buyers are etc (Annys et al. 2022). For instance, in the voluntary carbon market (VCM), results of carbon farming practices in the form of sequestered carbon might be sold as carbon credits or carbon certificates, which may be bought by various stakeholders in- or outside the agri-food sector. Here, buyers aim to offset part of their emissions and make claims about this using measured, reported and verified results. However, other arrangements exist. Carbon farming practices might be financed based on the activity and assumed benefits, or though indirect rewards (e.g. price premium on food products, access to agricultural land, reduced leasing costs, …). These alternative models may or may not contain the exchange of verified carbon certificates. It is interesting to explore the interests of stakeholders in various forms of carbon farming business models in order to better match expectations with desired outcomes for all stakeholders.

Q: Are retailers or food companies inside the agro-food sector running or proposing corporate supply chain schemes?
Q: Are there financing parties outside the agro-food sector willing to buy carbon certificates?

		Buyers of certificates, financers of carbon farming practices	
		Within agro-food chain	Outside agro-food chain
Business model	**Voluntary Carbon Market (VCM)** (by generating and selling carbon certificates)	**[BE]** Several stakeholders in the supply or demand side of agricultural products (business group active in agricultural sector, milling company, brewery) **[DK]** Certificates generated by Agreena are sold for offsetting purposes, mainly within the value chain. **[DK]** Selling certificates to provide capital for rewetting programs	**[BE]** Municipalities, provinces, telecom company, but also questions from construction projects, bike races etc. to offset their emissions. **[NL]** Municipalities, citizens and small private companies (outside the value chain). **[FR]** Generated certificates mainly sold outside agro-food chain (yet only 40% sold) – to avoid potential troubles with double counting; Livelihoods Venture (specific the Livelihoods Carbon Funds) who buys C credits for offsetting emissions (http://www.livelihoods.eu/)

			[IT] The European Commission's proposed provision on carbon removals excludes companies regulated by the ETS sector from the voluntary carbon market, while at the moment we believe that in Italy these are the actors most interested in purchasing voluntary carbon credits. **[AT]** Companies from the ETS sectors
	Outside VCM (no certificates but for instance labels, price premiums or other climate related claims)	**[BE]** many retailers with programs via labels, claims (Lidl, Colruyt, Milcobel) **[FR]** McDonalds at their contract farms, Soufflet malteries low carbon barley, Nataïs popcorn **[NL]** FrieslandCampina runs pilots, as does other Dairy company Aware with Ahold-Delhaize. Also Cosun. **[DE]** Volvic, Aldi, granini, Hipp (different types of labels and promises, very much criticized by the NGO foodwatch **[DK]** A point based system incentivising farmers to earn additional income from efforts for sustainable production (€0.03/kg milk additional payment for each point related to a specific effort) Arla earmarks up to 500 mEUR annually for rewarding climate activities on farm | Arla	**[FR]** Funders provide money to sponsor carbon projects in their own environment ('their own ecosystem') without being interested in possible carbon certificates or credits.

Different types of buyers can engage to finance the carbon farming system, via the VCM and result-based schemes or rather via activity-based payments outside the VCM. Organizing this asks for specific expertise as it is often complex. Therefore, in many countries, intermediary companies offer services for arranging different parts the VCM, which is interesting to explore.

Q: Are there intermediary companies involved (brokers, traders, certifiers) in the national VCM?

Except for Turkey and Austria the Road4Schemes experts reported different stakeholders that act as intermediaries in the VCM. The experts from the Czech Republic are not sure. These intermediaries engage in different steps in the process of rewarding carbon farming practices through business models. For example, there are companies that help get certain farming practices certified as carbon farming practices or companies that connect sellers of carbon certificates with potential buyers. Different countries might gain inspiration from an example from France.

INCC in France stands for Carbon Offset Info and is a platform to raise awareness of good carbon offset practices. On their website they provide a comprehensive list of intermediary stakeholders (called 'operators') in the VCM. They provide a filtering portal for both project leaders and potential funders who can to select geographical area, what type of certification (Label Bas Carbone, Gold Standard, VERRA etc.), what service is requested (setting up project, aide certification, sensibilisation etc.), in which sector (forestry, agriculture, waste treatment, energy usage etc. Operators - Carbon Offset Info (info-compensation-carbone.com)

4.1.6. Researchers' interests in the carbon farming system

All consulted experts from Road4Schemes partner countries indicated that there are ongoing carbon farming related research projects in their countries, or the execution of such projects is in preparation. In Turkey these are more related to initiatives for soil health and not specific for carbon farming. Some projects have a broad focus related to the carbon farming system (Home - Carbon Farming Certification System (c-farms.eu)) while others focus in depth on different aspects of carbon farming practices (EJP Soil CarboSeq: 'estimating the feasible SOC-sequestration potential taking into account technical and socio-economic constraints'). From the data it is not clear whether there are underexplored steps in the Road4Schemes partner countries' carbon farming systems. Regardless, it is good practice for researchers to take a step back and gather a holistic view, maybe using this exploratory system analysis exercise, and define whether there are aspects of the carbon farming system that are currently underexplored for their respective regions.

4.1.7. Other relevant stakeholders that were not questioned in this survey?

Several Road4Schemes experts identified stakeholders other than those proposed in the conceptual framework (farmers, civil society organizations, advisory services and education, policy makers, VCM stakeholders and researchers). This could deliver useful information for other countries, also outside the Road4Schemes partners.

Q: Do you think that there are other stakeholders who are relevant in your region?

- **Banks**:
  - *"Funders/banks that finance for instance new machinery to adopt carbon farming practices."* ***[FR]***;
  - *"In the Netherlands, also Rabobank tries to set-up carbon farming through 'carbon banking'."****[NL]***

- **Insurers:**
  - *"Insurers are considering positioning themselves to insure crops when farmers adopt practices that enable to increase carbon storage (AXA Climate https://climate.axa/fr/, Groupama)"* ***[FR]***

- **Knowledge sharing institutions**:
  - *"SEGES, the Farmers' Innovation- & Consultancy agency that is known by- and trusted by most farmers."****[DK]***;
  - *Knowledge sharing instances such as Resoilfoundation.org, and Edagricole.it, https://www.nucleomonitoraggiocarbonio.it/it/* ***[IT]***

- **Forestry and nature sector (and other land use sectors)**:
  - *"In Belgium, a trajectory is ongoing to organize carbon farming with different sectors (agriculture, forestry, nature)."* ***[BE]***
  - *CREA Carbon Monitoring Unit (https://www.nucleomonitoraggiocarbonio.it/it/)* ***[IT]***

- **Exporters organization:**
  - *Aegean Exporters' Association* ***[TU]***

4.2. Necessary conditions for a carbon farming system

a. Governance structure

Various stakeholders, from farmers to NGOs, VCM stakeholders and financing stakeholders, are looking for organisations to which they can turn to with their questions on carbon farming (see Facq et al. 2023 for an example from Flanders). The content of the provided answer should not depend on which organization is asking the question and to which organization the question is asked to, but rather be consistent, at least within a regional context. This is extremely difficult to achieve if all stakeholders operate independently without a clear system of governance. Unified, structured answers could be provided by a central contact point and an underlying discussion platform to make and disseminate decisions can be made on aspects such as the guiding principles, how to approach the first mover disadvantages, how to handle long term storage, additionality and what kind of climate-related claims to allow. At the bare minimum, a structure should be in place with the mandate and ability to translate the European initiatives on carbon farming to the regional level.

Q: Is there a central point of contact for questions about the carbon farming system by farmers and other stakeholders? Is there a platform/organization where guiding principles such as additionality, long term storage, leakage and co-benefits are discussed?
(if yes) How is this contact point organized, who is involved, who takes the lead?
(if no) According to you, which stakeholders should be leading the formation of a central contact point and governance structure in your country?

	Contact point	Who occupies this role? Or who should occupy this role?	Discussion platform	Who occupies this role? Or who should occupy this role?
NL	1	Slim Landgebruik = central contact point. Research and dissemination program of Ministry of Agriculture conducted by research institutes.	1	Slim Landgebruik, however not all principles are presented, Ministry has not decided yet.
AU	1	Humusplus organization HUMUS+ (humusplus.at) Raiffeisen Ware Austria (RWA)	1	Advisory Board of Soil Fertility and soil protection (Ministry of Agriculture)
DK	1	For national schemes (e.g. under the CAP): the agricultural agency. Furthermore, farmers can get guidance upon request from advisory services they relate to.	0	Themes raised here are more relevant from societal perspective, not sure who right stakeholders are to involve in this discussion (e.g. farmers?)
FR	0	Currently farmers turn to local contacts. Ideal would be: single entry point for practices and procedures, a directory of contacts (various stakeholders), and an information/data exchange platform. Ministry in charge (Agriculture) should organize.	1	Label Bas Carbone provides info about additionality, certified methods, but for more details stakeholders should contact other organizations. Discussions were led by I4CE, ministries and national stakeholders.
CZ	0		1	Academic researchers and professional research institutes is the platform to discuss these issues.
BE	0	A multi-sector governmental cooperation (agriculture,	0	A multi-sector governmental cooperation, which might be the

		environment, forestry and nature, climate, land use), that has the network to answer the incoming questions in a structural way.		same as the contact point. This is currently being developed in Flanders.
DE	0		0	A central platform to discuss the many ongoing discussions in all fields is lacking – probably because there is also still no consensus. German Environmental Agency (UBA) would be the main focal point. It also hosts the German Emission trading system focal point.
IT	0		0	Currently, there is not an organization which aggregates several stakeholders, but CREA has been designed as the body which will identify the guiding principles to be applied and open a public consultation in Italy in collaboration with governmental institutions.
TU	0		0	It could be NGOs with adequate capacity and experience or governmental institutions to adapt national strategies.

The Road4Schemes experts' responses show a variety in local situations. These results indicate that there is work to be done in developing the necessary governance structures for carbon farming schemes in Europe. Some indicate to have neither a central contact point or discussion platform exist (4/9). Few indicate to have one out of two (3/9) and only the Netherlands and Austria indicates to have both. The experts also provide interesting information on how these contact points and/or discussion platforms are (or should be) organized.

Governmental partners such as policy makers and agencies are often indicated as suitable stakeholders for organizing contact points or discussion platforms [FR, BE, DE, TU], or at least initiate the process [NL] which is then delegated to other stakeholders such as researchers. This is similar to what is done in Flanders (Belgium), where researchers (ILVO) and the department of Agriculture and Fisheries of the Flemish Government explored how the carbon farming system could be governed (roadmap by Facq et al., 2023). Using this roadmap as a basis, the department of Agriculture and Fisheries as well as the department of the Environment are cooperating with the Agency for Nature and Forestry and the Institute for Nature and Forestry research to divide responsibilities within the regional carbon farming systems between themselves and all relevant stakeholders in a co-creative process. In Italy a similar trajectory will be followed as the Italian research organization dedicated to the agri-food supply chains (CREA) will organize a public consultation and work together with governmental institutions. On the other hand, the experts from the Czech Republic indicate that while government guidance is necessary, there is also a manifold of semi-private advisory entities, which is considered to be sufficient and that there might not be "political will for a stronger role of government in navigating the advisory services".

b. MRV system

Regardless of individual preferences from stakeholders regarding the need for a thorough system of monitoring, reporting and verifying project results, it is clear that policy makers will require sufficient certainty to confidently state they are making progress towards their policy goals. Additionally, financing parties will require sufficient certainty to avoid accusations of greenwashing when making their desired green claims through carbon farming. All stakeholders want this process to be as cost-efficient and light on administration as possible. In order to gain insight in the various regional approaches to this issue we asked the Road4Schemes experts how they are proceeding with MRV systems.

Q: Is there a central, multi-stakeholder platform in your country where data, models and measurement methods for soil carbon fluxes/stocks are discussed?
(if yes) How is this platform on decisions and guiding principles organized, who is involved, who takes the lead?
(if no) According to you, which stakeholders should be leading the formation of a platform that discusses on MRV in your country?

	Central MRV-system for business models	Who occupies this role? Or who should occupy this role?
NL	1	Partly the Slim Landgebruik-platform and partly the SNK-platform (SNK = Stichting Nationale Koolstofmarkt; Foundation National Carbon market).
TU	1	There are models and monitoring efforts developed (SOC stocks and maps 'TOK', water and wind erosion, land cover classification). Currently no guidance provided at national level, which could be done by the Ministry of Agriculture and Forestry.
DK	0	SEGES (the Farmers' Innovation- & Consultancy agency) offers a tool that provides overview of fluxes (not official MRV-system), universities do the modelling and measurements of fluxes.
CZ	0	Researchers and government together. A government-driven methodology for MRV should be commissioned to research institutes.
BE	0	No such platforms in place yet but efforts are being done by ILVO (MARVIC project), department of Environment, INBO, soil service Belgium, Inagro, universities etc. to avoid double work constructing models, measurement protocols and data infrastructure. The **soil passport** has the potential to become such a platform, which uses the Roth C model for simulating soil carbon and can be used for both private and public initiatives. There is another tool for above ground C in agroforestry systems --> CARAT tool.
FR	0	Not at the moment, but being discussed in research projects, by Label Bas Carbone (and I4CE's Club Climat Agriculture). The lead should be Ministry in charge (agriculture) together with research institutes (such as INRAE) and should also involve bodies in charge of national GHG inventory methods to help include them in national inventories.
DE	0	There is the German Soil Inventory with verified methods that is the basis for the National Inventory Report. Also currently setting up National Soil Monitoring Centre to harmonize soil data among the different federal institutions, which is somehow multi-stakeholder. However, none of these platforms provide models for carbon farming practices.
IT	0	Efforts are ongoing, this should be done by research centres in collaboration with governmental institutions.
AT	0	This could be done by the Advisory board for soil fertility and soil health (Ministry of Agriculture)

Several Road4Schemes experts [FR, CZ, BE, FR, IT and AT] mention that the organization of a MRV-system should be done by a collaboration between research institutes and governmental organizations. Yet, it appears that, except for the Netherlands and Turkey, these collaborations are not yet in place. The question could be asked whether there are concrete steps taken where research institutes collaborate with governmental institutions in development of an MRV system? The experts from France also rightfully state that a collaboration to harmonize MRV-efforts should include governmental bodies working on national GHG inventories.

In Flanders (Belgium) a possible geospatial data platform to host an MRV system is the Soil Passport which starts from a digital passport for every individual land parcel which is registered. Every parcel contains both public data (GIS sources), but can also be complemented with private data, for instance from soil samples. Farmers can decide what private data to share, for what purpose and with what instances via the DjustConnect platform. Recently, the Soil Platform hosts a carbon calculator which can calculate the effect of several carbon farming practices (mineral soils and aboveground woody elements), based on the Roth C model (Beirinckx et al., 2023). The Soil Passport could be used to get access to business models related to carbon farming or associated ecosystem services. Also, this system might be transferable to other sectors as well, such as nature and forestry or private land owners.

4.3. Start-ups for carbon farming business models

Earlier in the Road4Schemes project existing carbon farming schemes from many countries (partner in Road4Schemes and beyond) were inventoried and grouped in three categories (after McDonald et al., 2021; Thorsøe, in preparation); farm payments (public financing, e.g. via Common Agricultural Policy), corporate supply chains (inside agri-food sector outside the VCM) and via the voluntary carbon market (buyers from both inside and outside the agri-food chain possibly).

Farm payments refer to an alternative term used for publicly funding carbon farming practices, often through subsidies like those provided by the Common Agricultural Policy. While many of these payments are tied to specific activities, there are also hybrid or result-based schemes, such as the SOC ecoscheme in Flanders, Belgium, where at least a part of the payment is determined based on the modeled or measured results of carbon sequestration. When taking a more inclusive approach to carbon farming and accounting for projects in forestry, wetlands and other land uses, the term **Public Payments** might be used to include governmental or regional programs, crowdfunding (with tax deductible donations), programs by NGO's and others.

In the **corporate supply chain business model**, companies provide farmers within their supply chain a modest financial incentive to adopt action-based carbon farming practices to reduce the carbon footprint of their products.

In **voluntary carbon markets**, private entities purchase offset credits or carbon certificates generated through carbon farming (Cevallos et al., 2019). These mechanisms are characterized by result-based payments and are facilitated either through intermediaries or exchange-based platforms.

In the next section the consulted experts provided an overview of these schemes in their respective categories and added new ones if relevant. This part of the exploratory system analysis gives an overview of what type of initiatives are prevalent and perhaps dominant in different countries. Furthermore we asked the experts what type has the most potential according to them. Please note that the identified initiatives might differ from the scheme inventory results as displayed on the Road4Schemes website (which is to be considered the most complete overview).

	Number of initiatives in three categories			
	Farm payments	Corporate supply chain	Voluntary carbon market	Most potential?
BE	1	5	3	Unsure, maybe farm payments. The new ecoscheme for SOC sequestration is doing well (apparently). Likely not corporate supply chains because farmers feel that possible price premiums are only temporary.
FR	1	1	2	Farm payments with for, instance, sector/price premium, would be an easier way, because VCM is too heavy (implying administrative burdens) and not financially viable. Besides that, corporate supply chains limit the freedom of farmers.
NL	1	7	6	Hard to say. Some farmers will like the first category, others the second and some farmers prefer the freedom to sell certificates if they want. The value chain partners are very eager to organise carbon farming within their own chain.
DK	9	1	2	Speculative, would depend on compensation levels risk and certainty.
DE *	4	0**	18	No clear preference of farmers for one option (focus groups). They regarded the additional income as desirable, but were also expecting disadvantages from any of the concepts. Farm payments are regarded as being too strict and bureaucratic, corporate supply chains are shifting power to the food sector, VCM includes intermediaries, who keep some of the money for themselves. In general, they were afraid of losing flexibility and autonomy.
CZ	2	1	1	Farm payments, but depends on the individual farmer attitude and community. There are more liberal ones who opt for VCM, but mainly conservatives who prefer farm payments.
IT	0	0	3	Agricultural payments from the CAP are the safest and most well-known type of payment, so farmers could favour this carbon farming option. These payments are based on activities performed or avoided. VCM requires a huge bureaucratic load and costs, while the income associated to it is still very low and not predictable, if credits are issued upon a result-based approach.
TU	0	0	0	"Corporate supply chains, because they are global players, and they generally sense any upcoming trend to adjust timely and not lose competitiveness. Most of them try to follow up with the developments and policies implemented in the EU"
AT	3	0	0	"Farm payments are the most important incentives."

** Overview of initiatives was completed by authors based on the Road4schemes scheme inventory results for Germany because German partners did not provide input on this part of the survey.*

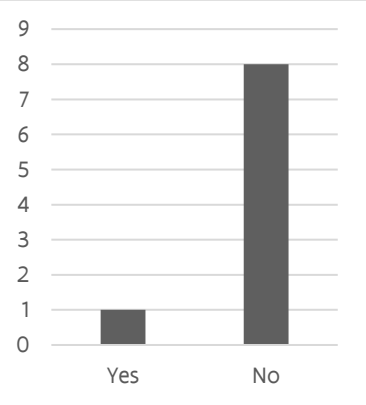
*** It seems corporate supply chain schemes were not included in the German inventory. This does not mean no such schemes exist in Germany, but it is the result of them not being considered by the German partners.*

Again the answers of the Road4Schemes partners show a variable situation considering existing business models associated with carbon farming practices. The experts indicate a possible preference of farmers for farm payments [BE, FR, NL, CZ, IT and AT], although they are often not

sure. Except for Denmark (9 schemes) and Austria (3 schemes) there are not many farm payment schemes available for farmers (none in Italy and Turkey).

Finally it was questioned whether there are governance initiatives to coordinate effects in these three different categories.

Q: Is there a governance initiative to coordinate efforts in these three different categories and avoid double work or competition? More specifically, are the three categories, to your opinion, complementary to each other or rather supplementary in your context?



Except for the Netherlands, all Road4Schemes experts state that there are currently no efforts done in coordinating the different carbon farming business model categories. In the Netherlands there are initiatives of their Foundation National Carbon Market (Stichting Nationale Koolstofmarkt, SNK) and their platform CO2 Neutral (Platform CO2 Neutraal) are providing some form of governance for the VCM initiatives, and both EU and National governments govern farm payments, while this is not the case for corporate supply changes.

The other Road4Schemes experts indicate that there are ongoing discussions about this topic and that it is recognized it as a possible issue. Often it is indicated that, for the moment, there are no problems yet, but it might become an issue in the future.

4.4. Regional or national upscaling of carbon farming systems

Earlier, the exploratory system analysis questioned different stakeholders' awareness of carbon farming practices and related business models. Awareness of the carbon farming system may lead to participation in carbon farming business models, but it is not clear what figures on participation are available.

Q: Are there numbers available about participation of farmers per design category (farm payment, corporate supply chain or VCM)?

The experts reported limited availability of data about participation in the carbon farming system, with most data-availability of farm payments (IT, BE, AT) and limited for the voluntary carbon market (DE, BE, NL). It is mentioned by several experts that data on participation in the VCM is fragmented, organized per scheme and provided on the own website of the VCM stakeholder (BE, NL, DE, FR). There are no statements about data availability for business models in corporate supply chains, only in Belgium and the Netherlands it was stated that there is very limited data available (some explain in news articles how many farmers and acreage they aim for). We assume that in the other countries, the situation is similar. The experts from Turkey, Denmark and the Czech Republic report that there is no data available, for any of the business models.

[FR]: *"It is difficult to find consolidated information if it exists."*

[NL]: *"As far as I know, there is not a central registration system in place."*

[DE]: *"..., information might reside at the level of the scheme-holder, but generally there is no public, transparent registry."*

Q: Are there agricultural sectors in your country that are underrepresented or lacking behind considering participation in the carbon farming system?
Q: Are there regions in your country that are underrepresented or lacking behind considering participation in the carbon farming system?

Several experts are unsure whether there is an underrepresentation of sectors or regions in carbon farming business models (BE, DE, CZ). Experts indicate that viticulture, vegetable farming and meat cattle in France and arable farming in Italy are underrepresented. In the Netherlands, Denmark, Austria and Turkey no sectors are underrepresented. Regional differences could be caused by the prevalence of local start-ups (BE), soil conditions (NL), manure production, (DK) or no specific reason mentioned (FR,TU).

	Sectors underrepresented		Regions underrepresented	
	Yes (1) / No (0)	Explanation	Yes (1) / No (0)	Explanation
BE	0	Methods available for all sectors (grassland, arable), but some methods might be more applied compared to others. Unknown for vegetable farming.	Unsure	Depending on pilot projects that locally engage farmers.
FR	1	Viticulture, vegetable farming and meat cattle	1/0	If some are up front, some are obviously behind
NL	0		1	Carbon rich regions or on rich clay soils farmers may think they do not need to consider carbon farming
DK	0	None	1/0	Eastern DK carbon deficit because manure produced in West DK
DE	Unknown		Unknown	
CZ		Too early to say		Too early to say
IT	1	Arable lands	0	
TU	0	Subsectors that target EU Market open up discussions	1	Possibly the Central, Eastern and Southeastern Anatolia regions could be lagging behind
AU	0		0	

In light of the upscaling of carbon farming systems, the Road4Schemes experts were asked to indicate where efforts are needed to raise awareness and a shared narrative.

Q: To your opinion, is there a need for more awareness about carbon farming systems? Is there a need for a shared narrative among stakeholders to set favourable conditions for carbon farming systems?

All experts indicate a need for more awareness raising in their countries. With regard to this awareness-raising, farmers and policymakers are mentioned by all experts, while society (BE), advisors and consultants (IT) and stakeholders in the value chain (TU) were also added. All experts (except for Austria) agree that in addition to increased awareness, a shared narrative on carbon farming is needed among different stakeholders in the system:

[BE]: "*We must avoid fuelling the dichotomy between climate adaptation and mitigation. Why should it be one of both? In Flanders both policy makers and farmers see benefits for climate adaptation, soil health etc. which shapes opportunities for win-win situations. Measuring and remunerating carbon removals can provide opportunities to achieve win-wins between many objectives because measuring other ecosystem services, such as biodiversity, are even more complex.*"

[FR]: *"There is a need to find a convincing narrative for farmers, showing towards which farming systems we are transitioning, how, and why as well as the advantages of these systems (including competitiveness and efficiency). And first it must be clear for farmers what carbon storage consists in (e.g., different from increased crop yields)."*

[NL] *"carbon farming is a relatively complex issue. How as a farmer can you be sure you reach certain amounts of carbon sequestration that you 'promised'."*

[DK] *"At least there is a need to align on which practices should be supported, currently there is a lot of disagreements."*

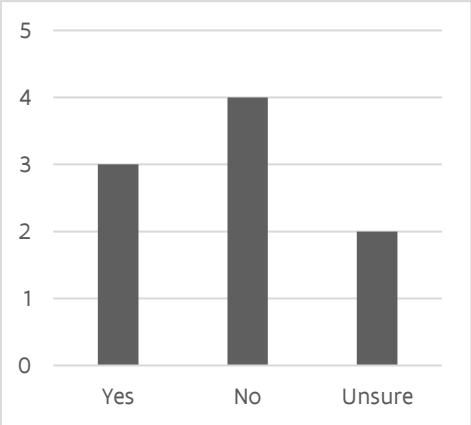
[DE] *"Right now, I would say, there is no clear promotion of the idea, because there are too many uncertainties – also with regard to the ongoing EU-CRCF process. These need to be solved first by a consensus among the main actors. After that, I think a shift in the perspective, would be necessary, to gain back credibility and regain a positive idea of Carbon farming."*

[IT] *"We highlight the need of a holistic and shared knowledge among relevant stakeholders for Carbon farming in Italy to guarantee progress towards the effective and sustainable application of carbon farming practices."*

Finally the experts were asked if they believe that some of the described pilot schemes would be capable to grow to a nation-wide system or approach.

Q: Are there pilot schemes that you studied that are capable of growing into a national system with high participation?

Some experts indicate schemes that are promising to grow, or are already implemented nation-wide. These examples make use of the VCM, but in other countries it is clear that these Monitoring, Verification and Reporting system needs to be improved before it can grow into a nationwide system.



[FR, yes] France Carbon Agri from IDELE (cattle farms) have over 3000 involved farmers, but there are difficulties in selling the produced carbon credits. Also CarbonThink (Terrasolis, region Grand Est) and Label Bas Carbone Grandes cultures could grow if uptake problems are resolved.

[DK, yes] These are already national schemes.

[IT, yes] Potential of all three types, yet uncertainty of the EU regulation on Carbon removals is hampering the system.

[NL, no] VCM is unsure, maybe CAP-payments can in the end match demands of EC for result-based schemes. Besides, the interest of chain value partners like dairy cooperatives is large to develop a system with their respective chains.

[DE, no] Uncertainties point out that we do not know what is needed for successful carbon farming systems. However, Moorfutures has proven to be more successful and combines private and public finance.

[TR, AT, no] No reason provided.

[BE, unsure] Maybe farm payments, for VCM the MRV systems need to improve.

[CZ, unsure] Premature to judge

4.5. Effective carbon farming systems

None of the Road4Schemes partners indicate to have a complete, well-functioning carbon farming system, as all Road4Schemes experts identified missing knowledge and growing potential for the carbon farming system in their country. Therefore, a relevant question to ask is what would constitute an effective carbon farming system.

Q: To your opinion, as a carbon farming expert in the Road4Schemes project, what is an effective carbon farming system in your country?
Q: What would be the message, the narrative of carbon farming systems that might be the most successful in your country or region? [Choose from, multiple possible: Climate mitigation, climate adaptation, soil health, regenerative agriculture, biodiversity conservation]

It appears that this question is interpreted differently by various experts. Some experts are pointing towards specific carbon farming practices or schemes [rewetting in NL, Moorfutures in DE, BlockCO2 with biochar and GECO2 in Italy]. Others discuss the preference for business models [combination of farm payments, corporate supply chains and VCM in the Netherlands and agri-environmental schemes, farm payments via CAP in Austria]. Others discuss the aim for achieving win-win-win situations [BE], affordable, accessible and accurate schemes [FR] and national policy strategies [TR].

Many experts agree that an effective carbon farming system should be able to achieve win-wins between climate mitigation and associated ecosystem services [FR, BE, DK, DE, IT, CZ]. Using carbon farming as a way to remunerate farming using the indicator carbon (SOC) that is relatively easy measurable (in comparison to climate adaptation, climate mitigation, soil health, regenerative agriculture …).

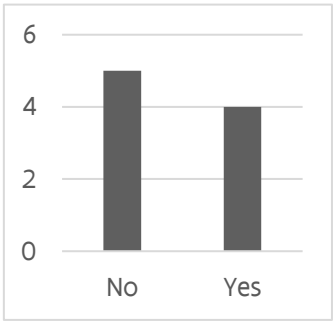
[BE]: "*A situation where we create* a *win-win-win between different targets (soil health, climate adaptation, climate mitigation). This should be possible as SOC is the number one indicator for soil health and resilience. Nowadays the word regenerative agriculture is used by anyone without clear definition or indicator. There is also a high risk for misuse. How will you proof that farmers contribute to soil health? How will you proof that something is regenerative agriculture? What is the basis for these kind of payments?*

[DE]: *"Climate adaptation, Soil health, If you ask for farmers participation and acceptance: climate adaptation and soil health are most attractive. For potential buyers of credits, however, it will rather be climate mitigation and biodiversity which is easier to monitor and hence better to communicate for marketing."*

[CZ]: "*Farmers consider agrienvironment as a valuable carbon farming method. Some farmers like the "regenerative agriculture label" partly because it sounds like they are doing good things but is so vague and it seems to be possible to cover any kind of extensification additional to CAP payments, …, however, regenerative agriculture has no legal definitions comparable to the mentioned two systems (agrienvironment and organic) and the regenerative label has very thin MRV"*

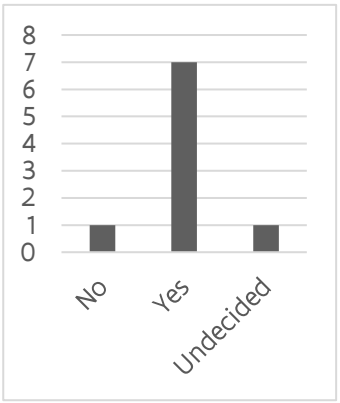
4.6. Finalizing questions

Q: Are there elements, according to you, that are missing in this exploratory system analysis?



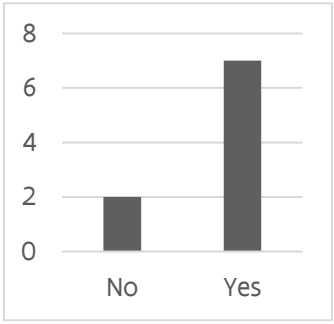
The experts from the Netherlands, Denmark and Turkey provide a similar suggestion, independently from each other. They state that variability within actor groups (here specifically farmers) is highly important to understand how the carbon farming system will work **[NL]**. We should take more into account the diversity of local farming systems, farm sizes, specialization as they all have different opportunities and barriers **[DK, TR].** There was furthermore no specific attention in this exercise for the uncertainty related to the upcoming EU regulation (CRCF) **[IT]**.

Q: Did the process of completing the questionnaire increase your understanding of the national carbon farming system?



The respondents confirm that it was a useful exercise for most of them. They mention that it was useful to gather updates and recent information on relevant activities **[TR]**, to have a more holistic view of the national system **[IT, BE, NL]** and to combine a lot of information that has been collected so far **[DK, NL, BE]**. In that sense, asides the resulting report, the process of completing the survey is also a useful output.

Q: Did you identify potential knowledge gaps by filling in the questionnaire?



The responses to this question show a high variety of identified knowledge gaps. Illustrative comments are that it was hard to find a clear vision from the government on the carbon farming system **[NL]** or that some departments of the government are more closely involved compared to others **[TR]**. Also it was stated that the perspective of farmers is still very much underrepresented and we do not know what would result in high participation**[DE].** This was confirmed by a statement that we do not know if the opportunities reach farmers in the right way, neither do we know how many farmers participate in different types of business models **[BE].**

5. Discussion

This report informs carbon farming policy design based on the insights obtained throughout the R4S project. The main goal, however, was to provide **starting points and a conceptual framework** to facilitate the creation of deliverable 4.5. 'A roadmap for further introduction of carbon farming and additional ESS payments' in the Road4Schemes project. Useful starting points and observations can be found throughout the results and discussion sections. These result from a cross-country comparison of the 'exploratory system analysis' which the Road4Schemes experts have conducted in their respective countries or regions.

We've provided a conceptual framework to analyse the development towards effective carbon farming systems in 5 steps. We want to note research leading up this framework has been validated by stakeholders within Flanders, Belgium. This conceptual framework however is a proposal which might well be adapted to suit the needs of the different stakeholders or project partners that want to use it.

5.1. Identifying similarities and differences between countries regarding the various steps towards effective carbon farming systems;

Using the survey, the Road4Schemes partners in each country were able to perform an exploratory system analysis and gain a structural and holistic overview of the current status of their carbon farming systems. By bringing the individual system analyses back together in this report, we can discuss some remarkable **(1) similarities** and **(2) differences**.

(1) Similarities

From the exploratory system analysis it appears that the Road4Schemes partners agree about the message to be delivered to farmers regarding carbon farming. The main points are as follows:

- As climate mitigation is an intangible effect, it has a its limits in motivating farmers to engage with carbon farming practices. Farmers would like to be viewed as contributors to climate change solutions, but the ways of giving them this recognition are delicate as they also want to avoid accusations of greenwashing;

- Therefore communication towards farmers should emphasise the possible direct benefits of carbon farming for them in the short- to medium term, such as soil fertility, climate adaptation and soil health. This communication should rely on the existing scientific knowledge regarding relevant farming practices;

This observation is contrasted by the fact that policy makers tend to mainly communicate on climate mitigation targets for the carbon farming system. One of the main reasons for this is the difficulty in quantifying the impact of carbon farming on various other policy goals such as biodiversity, water quality and soil health. In general, indicators related to climate mitigation (e.g. SOC and carbon sequestered in woody biomass) are relatively well developed and more practical to use compared to indicators for associated benefits. So while it is practical to employ SOC as an indicator of carbon farming success and as a basis for attracting financial means, it might lead to the perception that carbon farming only revolves around about climate mitigation based on a single parameter.

At the same time, the survey results show that in many participating countries policy makers from various domains actually do attach importance to the associated ecosystem services carbon farming might provide. In conclusion, this attached importance has to be translated in a clear and consistent narrative on carbon farming towards other policy makers, farmers, land managers and other societal actors (e.g. agro-ecological movements) to build and improve the sense of common purpose among them. In essence, stakeholders need to agree on the intentions of their carbon farming systems and find common ground.

Another observation is the fact that agricultural practices relevant to carbon farming are well known in most partner countries, while knowledge on carbon farming business models is lacking. However, farmers need this knowledge to inform them on how engaging with carbon farming will impact the ongoing activities on their farm and the economic sustainability of their farm. This conundrum could slow down the development of carbon farming initiatives. Practical experience is needed to construct better business models, but the lack of knowledge about them is preventing farmers from engaging with carbon farming on a voluntary basis.

When defining the intentions of a carbon farming system, we propose that policy makers together with their regional stakeholders could state that the first business models in a region are allowed to be 'imperfect sytems' with the aim of getting started with the concept rather than waiting for the 'perfect system' to be designed. This would include the conditionality that they eventually evolve towards more accountable and refined systems. This issue closely relates with the discussion on cost-effectiveness of MRV system design and the need for a conservative approach regarding green claims and non-permanence risks.

The surveys have further shown that carbon farming initiatives in most partner countries are being undertaken both inside and outside of a voluntary carbon market by a wide range of actors with many different motivations. This makes it difficult to assess how many farmers currently participate in each category of business model associated to carbon farming practices. This is a clear knowledge gap, pointing to the partly centralized as well as partly decentralized, parallel organization of initiatives on carbon farming. This also makes it more difficult to identify potentially successful schemes with high participation rates or to detect schemes that have failed or are failing (e.g. due to not being attractive for farmers). This shared challenge will need to be addressed in order to one day create central reporting platforms and/or national registries when working towards international harmonisation of carbon farming systems.

All of the Road4Schemes partner countries state they have identified at least some knowledge gaps and notice a growing interest and potential for carbon farming in their country. Therefore we can conclude none of the surveyed partners have arrived at step 5, which we termed 'effective carbon farming systems'. When asked how such a system would look like, the survey results showed an interesting spread of responses, which we summarized here. An effective carbon farming system should contain a clear distribution of multiple benefits adjusted towards the individual priorities of its stakeholders.

For example, climate adaptation and soil health effects should be directed towards farmers, while the more easily monitored effects of climate mitigation and biodiversity improvements might be directed towards financing stakeholders (who might make associated green claims). At the same time, costs and risks should also be fairly distributed to create an accessible, affordable and accurate system.

Additionally, an effective carbon farming system should be recognised through clear intentions (see discussion on carbon farming narrative above) and definitions (clear position with regards to associated terms such as agro-ecology and regenerative agriculture). Lastly, an effective carbon farming system should accommodate specialised schemes based on specific carbon farming practices (e.g. rewetting, soil amendments, agroforestry, …), it should support, learn from and build on current promising schemes and optimise combinations of financing pathways (farm payments, supply chain schemes, VCM) suitable to each type of scheme.

(2) Differences

The survey results have shown that the geographical location of countries influences how the importance of tackling climate change impacts, such as heat waves, drought or excessive rain, are perceived by stakeholders in that particular location. More specifically, some countries in north-western Europe are currently relatively less affected by climate change thus far compared to, for example, Italy, Turkey and southern France. This observation implies that the communication to engage farmers (and land managers in general) could be tailored to emphasise the most visible threat in each region. For example, emphasis on additional income might be more emphasised in northern Europe because local environmental conditions are favourable for carbon sequestration and the issue of economic sustainability is more of a 'top of mind' issue for farmers. In regions recently affected by floods or droughts, the emphasis can be put on relevant carbon farming practices to reduce the damages that might occur if the event were to happen again. In short, carbon farming requires a tailor-made narrative that links to the main objectives and concerns in the region.

The way that the carbon farming system is governed (or not) is highly different in the Road4Schemes partner countries. Some regions report having a central point of contact for questions and concerns on carbon farming as well as a discussion platform to make and disseminate decisions on the guiding principles and intentions for their carbon farming system. Others have only one or none of these functions fulfilled. Both public led, private led and public-private collaborations exist or are intended to be created. The agencies or departments responsible for agriculture or the environment are often mentioned as key players in these functions. Other stakeholders mentioned are research institutions, NGO's, agri-food supply chains and advisory services and farmers. Regardless of the differences in approach, all survey respondents report additional work is needed to create and/or improve their contact points and discussion platforms. A similar pattern occurs regarding the discussions and decisions on data, models and measurement methods for soil carbon fluxes/stocks. Collaborations between research institutions and governmental agencies seem to be the main drivers.

The estimations by partner countries regarding local initiatives belonging to specific carbon farming scheme categories (Farm payments/public payments, corporate supply chain schemes and voluntary carbon market schemes) has delivered some interesting results. While we do not attach too much importance on the exact numbers of identified initiatives for each category, the responses regarding their potential reveal that Road4Schemes experts see important differences between these categories. They mention the advantages and disadvantages of different categories from the farmer's perspective, revealing some interesting observations:

Farmers are expected to have a personal preference regarding the category of carbon farming scheme in which they would like to participate. These preferences reveal interesting trade-offs:

- Farm payments/public payments: considered safe, well known and straightforward, but an administrative burden for farmers.

- Corporate supply chain: Supply chain actors are motivated to engage with farmers, offering financing solutions such as price premiums on products, resulting in reduced administrative burdens. At the same time there are concerns on the power dynamic between farmers and supply chain actors and the potential temporary nature of price premiums.

- VCM: The freedom to sell certificates or credits when you want and to whom you want might be attractive, but intermediaries in the VCM might limit potential income too much.

We want to add to this discussion that the same preferences and trade-offs could be identified for other stakeholders as well. For example, policy makers might like the control they could have by increasing farm payment/public payment schemes, but dislike the associated costs and administrative costs. They might encourage private finance being mobilised by corporate supply chains and the VCM, but be concerned regarding the general outcomes of these types of schemes if they are left to make their own rules and principles on carbon farming.

We believe recognising the differences between how the different categories of schemes try to achieve the goals of carbon farming will help to create a coherent strategy for developing regional carbon farming systems.

5.2. Highlighting the potential for international learning in order to inspire other countries and regions in Europe.

It is helpful to compare the different situations in the partner countries to allow exchange of inspiring ideas and best practices. For instance, considering the governance structure for the carbon farming system, only the Netherlands and Austria indicate to have both a centralized contact point and discussion platform. From information provided by these partners, other countries can get inspired on how to organize themselves. Furthermore, since many Road4Schemes experts indicated that they expect farm payments to be popular among farmers , they can check whether there are enough of these schemes available and if not, take inspiration from countries where more or other types of CF schemes are available and see if they are transferable to their situation.

This report further indicates that no single frontrunner outperforms the other countries on all steps and thus all partner countries can benefit from sharing insights on the design and implementation of carbon farming systems. To make this statement concrete, we make an attempt below to link knowledge gaps with an inspiring example from each Road4Schemes partner country. Again, this is only a small part of the possible transferable lessons that are undoubtedly included in the results section of this report. Once again, we invite the reader to peruse the results section of this report and be inspired by different approaches.

Road4Schemes partner country	Transferable lesson	Step
France	Providing an accessible overview of VCM intermediaries and what services they could provide to each interested actor in a specific region.	1
Czech Republic	Disseminating information for both public and private consultants by academics working with the latest insights from the carbon farming system.	1
Italy	How the prevalence of climate extremes (e.g. severe droughts followed by floods) in Italy affects the importance of the message for farmers (climate adaptation and soil protection from climate extremes).	1
Belgium	The Soil Passport that serves as a digital plot-based platform to collect both private and public data. Together with the carbon simulator for carbon farming practices and agroforestry systems, this platform can help minimise administrative burdens and thereby make MRV systems more efficient.	2
Denmark	Many possibilities for farm payments, with particular focus on lowland areas and the possibilities of rewetting and protecting peatlands.	3
Germany	The need to gain back credibility and a positive idea of carbon farming. This needs to be solved via a consensus among the main actors and a shift in perspective.	4
Netherlands	The Smart Land Use programme was designated as a central contact point for questions on carbon agriculture from various actors.	Several
Turkey	Insights in how trading arrangements (export of products) could influence awareness or behaviour of farmers under contract.	Several

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Annex I: Survey Task 4.2 (WP4 EJP Soil Road4Schemes)

Step one: awareness of different stakeholders about carbon farming systems

- **Why do we need to assess this**

"Unknown makes unloved". Carbon farming practices and opportunities of carbon farming schemes may not be under the attention, especially since there are many pressing issues within the agricultural sector. The main focus of the first step in building a carbon farming system is to assess whether carbon farming is under the attention of farmers, as well as other relevant stakeholders.

- **Questions**

[Q1] Considering farmers [Information from WP3 focus groups / surveys might be useful here]

	Carbon farming practices[2]	Carbon farming as business model[3]
To your opinion, is there awareness among farmers that certain practices (e.g. rewetting grasslands) are influencing carbon sequestration (left) and about carbon farming as business model (right)?	☐ None ☐ Some ☐ Considerable ☐ Much	☐ None ☐ Some ☐ Considerable ☐ Much
Is this awareness growing?	☐ Yes ☐ No	☐ Yes ☐ No
Is this awareness region-specific?	☐ Yes ☐ No	☐ Yes ☐ No
Is this awareness specific for farming sectors (livestock, arable, mixed)?	☐ Yes ☐ No	☐ Yes ☐ No
Do you have information, examples to illustrate/support the statements made above? (textbox)		
Which steps have been taken in your country to spread information about carbon farming practices or carbon farming as business model to farmers? (textbox)		

[2] Carbon farming practices such as (adapted) crop rotation, catch crops, peatland rewetting are beneficial for carbon sequestration in the soil, but are not necessarily applied for this purpose (but e.g. for nutrient management, biodiversity).
[3] The opportunity that sequestration of carbon in the soil can generate additional income.

Is the local discussion about carbon farming practices or business models linked with related agri-environmental issues like climate adaptation, nutrient management or biodiversity protection (co-benefits/associated ecosystem services)?	☐ No ☐ Climate adaptation ☐ Nutrient management ☐ Biodiversity protection ☐ Other?	☐ No ☐ Climate adaptation ☐ Nutrient management ☐ Biodiversity protection ☐ Other?
To your opinion, do you think that it is better in your country to promote farming practices for climate adaptation, soil health and biodiversity with climate mitigation as co-benefit, or the other way around? (textbox)		

[Q2] Considering national civil society organizations (e.g. environmental NGO's, organizations in support of agroecological transition)

To your opinion, is there awareness among civil society organisations about carbon farming as business model?	☐ Yes ☐ No
Were there civil society organizations actively involved in debates about national/regional carbon farming systems?	☐ Yes ☐ No
(if yes on either of the above statements) Do you have examples? For instance from news articles. What are the opinions? (text box)	

[Q3] Considering farmer advisory services

Are carbon farming practices and/or business models included in agricultural education?	☐ Yes ☐ No
Are carbon farming opportunities included in public or private advisory services?	☐ Yes ☐ No
(if yes on either of the above statements) Do you have examples? (text box)	

[Q4] Considering governmental institutions [Information from WP3 policy-survey can be used]

E.g. agriculture, climate, environment	Domain 1 **(to adapt)**	Domain 2 **(to adapt)**	Domain 3 **(to adapt)**
Are these domains aware of the potential of carbon farming practices?	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
For which domains is there information on the respective governmental websites?	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
Can you provide links to these websites? (textbox)			

What do these policy domains expect primarily from carbon farming practices?	☐ Climate mitigation ☐ Climate adaptation ☐ Nutrient management ☐ Biodiversity protection ☐ Not clear ☐ Other?	☐ Climate mitigation ☐ Climate adaptation ☐ Nutrient management ☐ Biodiversity protection ☐ Not clear ☐ Other?	☐ Climate mitigation ☐ Climate adaptation ☐ Nutrient management ☐ Biodiversity protection ☐ Not clear ☐ Other?

[Q5] Considering stakeholders in the voluntary carbon market [Information from the WP2 might be helpful]

Are there financing parties outside the agro-food sector willing to buy carbon certificates?	☐ Yes ☐ No
Do you have examples? (textbox)	
Are retailers or food companies running or proposing corporate supply chain schemes?	☐ Yes ☐ No
Do you have examples? (textbox)	
Are there intermediary companies involved (brokers, traders, certifiers) in the national VCM?	☐ Yes ☐ No
Do you have examples? (textbox)	

[Q6] Considering researchers

Besides Road4Schemes, are there **national or regional** research projects in your country about carbon farming systems ongoing (also other research institutes)?	☐ Yes ☐ No
Or in preparation?	☐ Yes ☐ No
(if yes on either of the above statements) Can you specify the focus (and links) for each of the projects? (text box)	

[Q7] Other national/regional stakeholders?

Do you think that there are other stakeholders who are relevant in your region?	☐ Yes ☐ No
(if yes) Which ones? And why (text box)	

Step two: necessary conditions and infrastructure for carbon farming

- **Why do we need to assess this**

Stakeholders involved in carbon farming systems (e.g. financing, farmers, governments) have different ideas and expectations of carbon farming systems. This often leads to misunderstanding, criticism and mistrust. Building further on awareness of these stakeholders, efforts are needed to create a shared narrative and language among stakeholders about carbon farming systems. Another necessary condition is a well-functioning MRV-system that aligns with the shared narrative.

- **Questions**

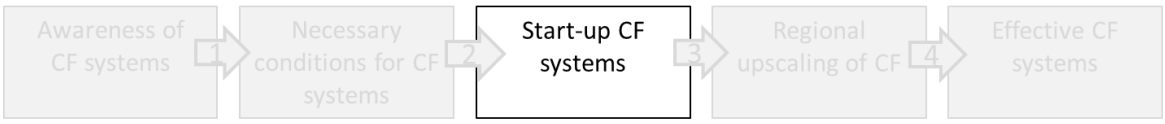
[Q8] Governance structure

Is there a central contact point for questions about the carbon farming system by farmers and other stakeholders?	☐ Yes ☐ No
(if yes) How is this contact point organized, who is involved, who takes the lead? (textbox)	
Is there a platform/organization where guiding principles such as additionality, long-term storage, leakage and co-benefits are discussed?	☐ Yes ☐ No
(if yes) How is this platform on decisions and guiding principles organized, who is involved, who takes the lead? (textbox)	
(if no) According to you, which stakeholders should be leading the formation of a central contact point and governance structure in your country? (textbox)	

[Q9] MRV decisions [WP3.2 expert-survey might be helpful here]

Is there a central, multi-stakeholder platform in your country where data, models and measurement methods for soil carbon fluxes/stocks are discussed?	☐ Yes ☐ No
(if yes) How is this platform on decisions and guiding principles organized, who is involved, who takes the lead? (textbox)	
(if no) According to you, which stakeholders should be leading the formation of a platform that discusses on MRV in your country? (textbox)	
Is it clear which SOC models for different carbon farming practices are available and are these shared among stakeholders in the carbon farming system?	☐ Yes ☐ No

Step three: pilot projects, start-ups

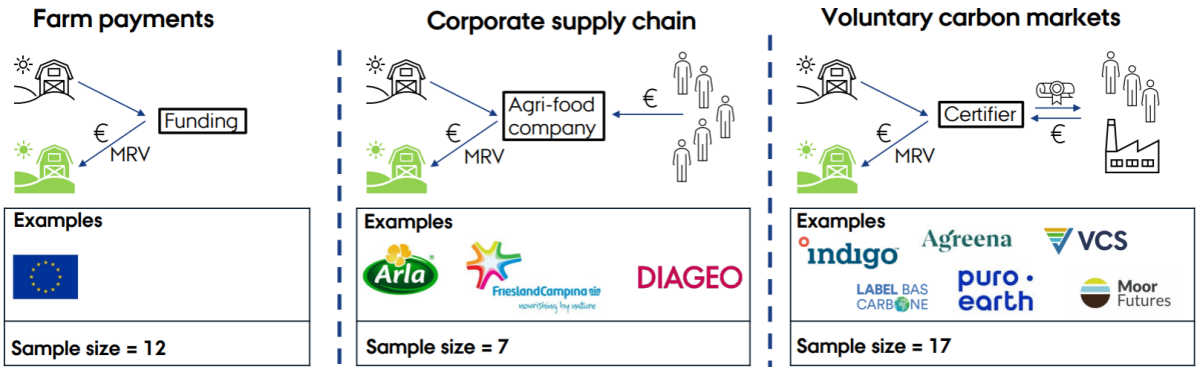


- **Why do we assess this**

The growing awareness of various stakeholders **(step 1)** and the emergence of necessary conditions **(step 2)** create favourable conditions for start-ups to experiment and launch the carbon farming system. One of the purposes of the Road4Schemes project was to identify success factors or barriers in pioneering carbon farming schemes in different countries. Apart from this ongoing exercise we can locate these initiatives in relation to the whole carbon farming system that we are assessing (explorative) with this questionnaire.

- **How do we assess this**

During the EGU session Martin presented the outcomes of the inventory in WP2 in a useful categorization of three design options in the carbon farming system:



In this questionnaire we can assess how these initiatives relate to the other steps in the carbon farming system.

- **Questions** [Information from WP2 + WP3 policy survey can be used here]

[Q10] - The subset of your country in the first inventory of WP2 can be re-entered and categorized in the table below, and might be supplemented with new or upcoming initiatives that were not yet included in the inventory.

Name + 'ID2' in inventory	Farm payments	Corporate supply chains	Voluntary carbon market
Example Claire Belgium (13)			*X*
Example Ecoregeling (12)	*X*		

To your opinion, is there (or would there be) most interest of farmers for farm payments, corporate supply chains or the VCM? And why? (textbox)	
Is there a governance initiative to coordinate efforts in these three different categories and avoid double work or competition? More specifically, are the three categories, to your opinion, complementary to each other or rather supplementary in your context? (textbox)	

Step four: national/regional upscaling of carbon farming systems

- **Why do we assess this**

Many countries are somewhere in between creating necessary conditions for carbon farming **(2)**, pilot schemes starting up **(3)** and trying to align these initiatives for regional upscaling **(4)**. However, it might be necessary for countries to invest more time in creating awareness among different stakeholders **(1)** before continuing attempts to scale up the carbon farming system. Also, several countries encounter barriers to scale up seemingly promising schemes due to lacing necessary conditions **(2)**.

- **Questions**

[Q11] – National upscaling of carbon farming systems

Are there numbers available about participation of farmers per design category (farm payment, corporate supply chain or VCM)?	☐ Yes, clear pooled figures ☐ Yes, but scattered ☐ Only partly available for … ☐ No information available
Could you elaborate on this? (textbox)	
Are there agricultural sectors in your country that are underrepresented or lacking behind considering participation in the carbon farming system?	☐ Yes ☐ No
If yes, which ones? (textbox)	
Are there regions in your country that are underrepresented or lacking behind considering participation in the carbon farming system?	☐ Yes ☐ No
If yes, which ones? (textbox)	

[Q12] – Needs for enabling national carbon farming systems

To your opinion, is there a need for more awareness about carbon farming systems?	☐ Yes, for farmers ☐Yes, for policy makers ☐ Yes, for …
Is there a need for a shared narrative among stakeholders to set favourable conditions for carbon farming systems?	☐ Yes ☐ No
Could you explain this? (textbox)	
Are there pilot schemes that you studied that are capable of growing into a national system with high participation?	☐ Yes ☐ No
Could you explain this? (textbox)	

Step five: what is expected from the carbon farming system in your country?

- **Why do we assess this**

It may differ what countries or regions expect from the carbon farming system and thus what the regional goal is for the carbon farming system. Is it climate mitigation or providing impulses for transition of farming systems to sustainable practices, or providing transition budget for the farmers?

- Questions

[Q15] – What would be an effective carbon farming system in your country?

To your opinion, as a carbon farming expert in the Road4Schemes project, what is an effective carbon farming system in your country? (textbox)	
What would be the message, the narrative of carbon farming systems that might be the most successful in your country or region? (more possible)	☐ climate mitigation ☐ climate adaptation ☐ soil health ☐ regenerative agriculture ☐ biodiversity conservation
What would be a good endpoint of the Road4Schemes roadmap for your country? (textbox)	

Finalizing questions

[Q16] - How did you perceive this questionnaire?

Are there elements, according to you, that are missing in this exploratory system analysis?	☐ Yes ☐ No
If so, which elements would you like to add? (textbox)	
Did the process of completing the questionnaire increase your understanding of the national carbon farming system?	☐ Yes ☐ No
Could you explain why yes or no? (textbox)	
Did you identify potential knowledge gaps by filling in the questionnaire?	☐ Yes ☐ No
If so, what knowledge is needed? (textbox)	

[Q17] - Who was involved in completing this questionnaire? Who was questioned in the process?

Name	Organization	Email	Role in completing questionnaire
Example Frederik Gerits	*Flanders Research Institute for Agriculture, Fisheries and Food*	*Frederik.gerits@ilvo.vlaanderen.be*	*Taking the lead in the questionnaire and inviting other regional experts to reflect and provide information.*
Example …	*Innovation support Centre in Flanders, who provides consultation to farmers considering agricultural innovation*	*…*	*Provided information on the questions about awareness of farmers from different sectors about carbon farming business opportunities. Answered to question posed by Frederik via email.*

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