

# LAYMAN'S REPORT

Coordinating beneficiary



Associated beneficiary



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## CONTEXT

### The importance of carbon farming for climate neutrality in agriculture and land sector in EU

The EU has started a deep decarbonisation path towards the achievement of the Paris Agreement for climate neutrality by 2050.

Agriculture and the land sector in general, are key to meet this goal, and the development of **Nature Based Solutions** to reduce and remove CO<sub>2</sub> emissions is essential. **The Circular Economy Action Plan** (CEAP - COM/2020/98 final), as well as the **Farm to Fork strategy** (COM/2020/381 final) have indicated the development of a certification system as a prerequisite for the activation of a regulatory framework that incentivises the **Carbon Farming practises**. In December 2021, the Commission adopted the **Communication on Sustainable Carbon Cycles**, setting out medium-long term actions to promote carbon farming practices under the Common Agricultural Policy and to fix the conditions for a standardisation of monitoring, reporting and verification methodologies in order to provide a reliable framework for carbon farming.

The agricultural sector is the most challenging in achieving emission reductions, also considering the competing and increasing demand of food, energy and wood production. Actually, farmers are paid to reduce emissions or sequester carbon in order to incentivise the implementation of carbon farming practices. Action-based payments are commonly applied in the second Pillar of CAP regulating Rural Development Policies but the mitigation impact is not easy to define, depending only on the action and not on the result. Result-based payments linked to the outcome in terms of quantification and verification of the CO<sub>2</sub> sequestered are more reliable in terms of environmental effect. The contribution of result-based carbon farming in the EU's efforts to tackle climate change has been the most important conclusion of a technical handbook published by the Commission (April 2021) on how to set up and implement carbon farming in the EU. Concerning that point, one important challenge is the definition of the process and the quantification of costs of monitoring and certification of the carbon removals.

The C-FARMS project fits within this context by providing a certification system suitable for finding the right balance between effectiveness in capturing the real benefit in terms of climate change mitigation of the Carbon farming practices and designing a system to incentivize sustainable practices among farmers.

#### WHAT IS "CARBON FARMING"

Carbon farming is defined as a carbon removal activity related to land use or/and management that results in the increase of carbon sequestration in living biomass, dead organic matter and soils, compared to conventional practices, by enhancing carbon capture and/or reducing the release of carbon to the atmosphere.



## THE PROJECT

In connection with the new CAP and other regulatory systems under the EU climate policies, the **C-FARMS project has developed a regulatory framework for the certification of Carbon removal** (or Carbon non-emission) based on a robust and transparent carbon accounting scheme in connection with the national GHG inventory. It will support the design and implementation of targeted and result-based payments to farmers for the application of Carbon Farming practices.

C-FARMS also addressed the gap in data required to characterise the GHG fluxes in the agriculture sector building a possible system for data collection at local level meant to improve the emissions factors database in connection to the National GHG inventory system.

C-FARMS involves in the certification system the wood industry for incentivizing the use of local wood to create an increment in demand that can stimulate the afforestation of new areas, with an overall carbon and environmental benefit.

All the project is developed by sharing information among partners and stakeholders. Institutions, farmers, wood processing industries associations, and the general public were involved in the design of the system from the beginning, so as to increase the efficiency as well as the level of acceptance of the proposed carbon certification system and the feasibility of the demonstrative actions in the regional context.



Lombardy Region is the pilot area where the carbon farming certification system was tested.

### Pilot study: the Lombardy Region

The research activity of the C-FARMS project was conducted in **Lombardy Region**, one of the most important agricultural regions in Italy and an interesting testing area for a pilot system of Carbon Farming certification. Lombardy ranks first in agricultural production, due to the wide agricultural area (around 1 million hectares, according to the last Agricultural Census of 2020, **representing 8% of the Italian agricultural area**), the abundance of fertile soils and availability of irrigation water in the plains of Po river valley. Lombardy is at the top of the Italian regions in cereal **production** (maize, rye, barley, wheat, rice, commonly grown in continuous cropping systems) **and forage for highly specialised livestock activities**. Intensive agriculture and livestock concentration (more than 40% of regional farms breed animals) have become two important environmental concerns, being partially responsible for nitrogen pollution and CO<sub>2</sub> emissions, with serious consequences in air and environmental quality. However, the evaluation of carbon sequestration capacity of regional soil under alternative scenarios highlights the positive impact of the implementation of conservation agriculture. According to a study<sup>1</sup>, Lombardy has a potential soil organic carbon (SOC) sequestration rate ranging from 3.5 and 4.2 tCeq/ha/year with a feasible soil involvement in carbon management practice.

In addition to the agricultural sector, the analytical framework of C-FARMS has included the **poplar tree plantation**. Italy is among the largest producers of wood furniture in the world, however 80% of wood is imported from abroad. **Italian poplar plantations represent the most important segment of industrial timber production for the plywood, packaging, pulp and paper, and wood-based panels industries** (around 70%). However, of the 115,000 hectares required for satisfying the national demand of poplar wood, only 45,000 are present in Italy. The large majority of these plantations (over 90%) is grown in the plains of northern Italy, in particular in the Po valley. The role of poplar plantation is CO<sub>2</sub> sequestration is widely recognized although there has been no comprehensive study of how the management practices or different poplar genotypes affect the CO<sub>2</sub> sequestration. When sustainably managed, poplar plantations provide other environmental services, such as decrease of fertiliser pollution, soil protection and soil quality improvement. Moreover, the introduction of clones named MSA<sup>2</sup> in substitution of the clone I-214 is also setting up as a valid option to increase the carbon storage in the biomass thanks to the increased growth.

<sup>1</sup> Brenna, Stolbovoy, Rocca, Sciacalunga (2010). Potential carbon sequestration of Lombardy soils (Italy), 19th World Congress of Soil Science, Soil Solutions for a Changing World, Brisbane (Australia)

<sup>2</sup> Clones offering greater environmental sustainability (Maggiore Sostenibilità Ambientale in Italian, thus referred to as MSA clones) characterised by better resistance to the main biotic adversities.

## OBJECTIVES

The project is divided in seven actions which objectives include:

- Creating high-resolution demonstrative geospatial information system (GIS-FARMS), to identify the mitigation potential of the agricultural sector of Lombardy Region
- Systematising existing knowledge and data with relevance for the area of interest useful for the creation of the high-resolution demonstrative geospatial information system (GIS-FARMS)
- Identifying information and research gaps
- Supporting the development of a regulatory framework for a carbon certification system in collaboration with relevant stakeholders
- Verifying the possibility of use of common methods and/or reference data and/or data sets in participation with climate change research institutions, as well as mutual exchange of knowledge on greenhouse gases from the agricultural sector
- Supporting design and implementation of targeted payments for the application of Carbon Farming practice.





## ACTIONS AND RESULTS

To meet the objectives of the project, the following actions have been implemented:

### • PHASE 1

#### **ACTION 1 • Farms statistical and economical data and spatial information gathering**

The first action of the project was focused on the **identification of the available statistical and geospatial datasets** to build a solid knowledge to support decision-making carbon farming in the agricultural sector. The Italian FADN (RICA) has been one source of information for the selection of the most important farm types in Lombardy: FADN collects microeconomic data of a statistically representative sample of agricultural holdings, classified according to the standard production. FADN data has been also used to perform a first economic analysis of the farms operating under the measures of conservation agriculture provided in Lombardy (in terms of gross margin per hectare of the main cultivated crops). The same action has also defined the sample of farms growing poplar in Lombardy and their surface by Province. The selection has considered the geographic distribution, the soil type and other farm characteristics representing the regional poplar farming. For the whole region, a data collection activity to retrieve geospatial datasets suitable for being processed in a GIS environment was undertaken. **These datasets have permitted the spatial representation of current SOC stocks and the key variables controlling the potential of carbon storage** (environmental factors, soil properties, land use, crop type).

#### **WHAT IS FADN**

The Farm Accountancy Data Network (FADN) is the only source of microeconomic data based on harmonised bookkeeping principles and carried out with the same methodology in all the European Member States since 1965. FADN monitors farms' income and business activities and is an important informative source for the impact analysis of the measures taken under the common agricultural policy. CREA-PB is the Liaison Agency for FADN in Italy. Actually, the need to collect information regarding environmental and social aspects of farming activity is giving rise to the conversion of FADN in FSDN (Farm Sustainability Data Network).

## Action2 • Carbon farming practices-cropland and livestock management.

The action has identified and quantified a **set of sustainable management options** (relevant for mitigation purposes) for the main existing crop and livestock systems in Lombardy, based on the most important type of farming characterising the regional agricultural sector. Further information has been collected through a direct questionnaire filled by the farmers and asking for the most important carbon farming practices conducted in the farm and the farm perceptions regarding the mitigation potential deriving by a more sustainable farming management. The most important outcome of this action has been the **definition of the carbon sequestration rate for a set of carbon farming practices** given the main characteristics of the region. These rates have permitted to estimate the soil organic carbon loss/gain in each farm and the potential in case of a more sustainable management. The carbon sequestration rate for each practice has been estimated using the Stock Difference Method (IPCC, 2006).

### STOCK DIFFERENCE METHOD

$$\Delta \text{SOC} + \text{C ha}^{-1} \text{ yr}^{-1} = (\text{SOC STOCK } t1 - \text{SOC STOCK } t0) / \text{years}$$

where:

SOC STOCK t1: follow-up carbon stock, i.e., carbon stock measured after the experiment in the treatment plot, ( $\text{t ha}^{-1}$ )

SOC STOCK t0: baseline carbon stock, i.e., carbon stock measured before the experiment in the treatment plot, ( $\text{t ha}^{-1}$ )

years: duration of the experiment



### Action 3 • Carbon Farming - Tree Plantation and Harvested Wood Products.

The action is focused on the **poplar plantation and provides an analysis of the capacity of poplar plantations to mitigate climate change**, both in relation to the soils and the contribution made by Harvested Wood Products (HWP), of which post-harvest processes were also considered.

**The action has therefore updated the mapping of poplar plantations, through the analysis of Sentinel-2 satellite images of the multispectral sensor (MSI) and of the vegetation indices (such as NDVI).** The mapping of the poplars has identified the areas of poplar plantations with a surface greater than 0.5 ha and an age greater than 4 years in the areas close to the Po Valley until the year 2021. The action has analysed the high environmental sustainability of the MSA clones, more tolerant to the main pests and diseases, less demanding in terms of cultivation, more productive in terms of yield. The use of MSA in place of I-214 (the most common clone in the Italian growing poplar area) has a high carbon sequestration potential.

#### • RESULTS PHASE I

**The recognition of different data sources for the farm-level sustainability assessment and the selection and characterisation of a representative sample of farms dealing with agronomic production, cattle breeding, tree plantation and wood transformation**, were the prerequisite for (i) the definition of the current situation (baseline) of farm management and the room of improvement in case of shift towards more sustainable practices; (ii) the definition of a High-resolution geospatial information system of the regional territory.

The conclusions of this first phase can be synthesized as follows:

- there is a lack of studies about different carbon-farming practices in Europe;
- the estimation of the sequestration rate for each carbon farming practice depends by different variables and the definition of the organic carbon loss/gain is uncertain; however this information is crucial for the scenario analysis and for a first evaluation of environmental and economic impacts at farm level;
- trees and forestry ecosystems are crucial for granting carbon stocking in terrestrial ecosystems: growing poplar areas have an important role in this framework, potentially strengthening with the use of more sustainable poplar clones;
- a Life Cycle Assessment analysis is necessary to evaluate the contribution of carbon-farming practices to the mitigation of climate changes effects.

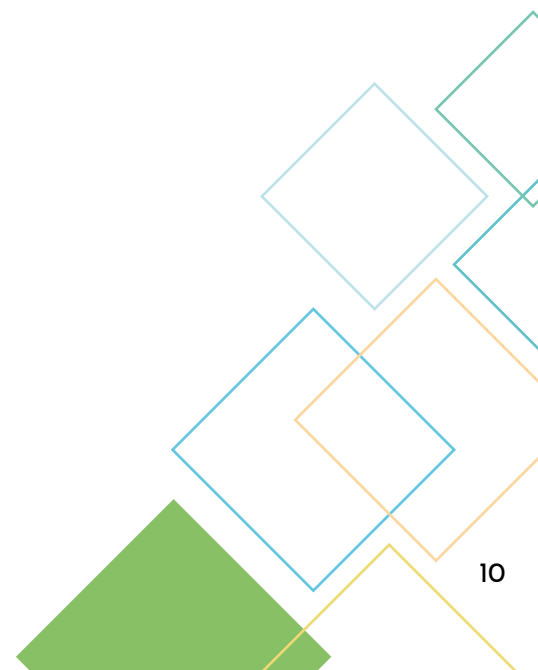
## • PHASE 2

### Action 4 • Creation of the High-resolution geographical information system for the reference region (GIS-FARMS).

One of the main outputs of the C-FARMS project is the Carbon Farming Simulator "GIS-FARMS", a **prototype of a geo-spatial information system that allows users to simulate scenarios on the potential for carbon sequestration rate**, associated with the adoption of carbon farming practices. The application enables analyses at both farm and regional level.

Specifically, the C-FARMS project has generated new and reliable levels of information on the initial SOC (Soil Organic Carbon) level of agricultural soils and the associated carbon sequestration potential, while simulations of the carbon sequestration rate for a set of carbon farming practices are provided by two different simulation algorithms:

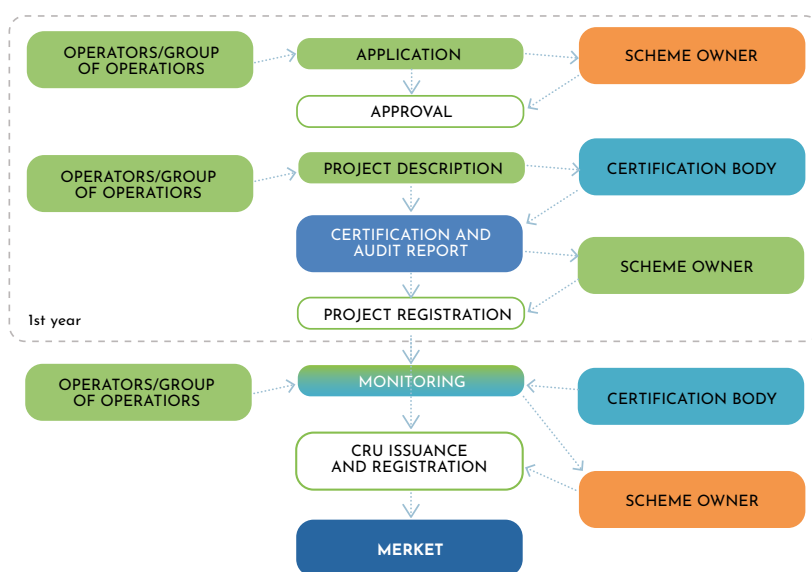
- the 'IPCC method' is based on the IPCC guidelines (IPCC, 2006) to assess the change SOC stock as a function of changes in agricultural practices (simulated by the user) and environmental constants. Simulations with the 'IPCC' method are possible over the entire agricultural area of Lombardy;
- the 'C-FARMS method' (Università degli Studi della Tuscia, 2022) enhances instead the spatial integration of existing geodatabases (FAO GSOC map, Climatic stratification of the Environment of Europe, Land use and soil use map of the Lombardy Region); it is based on the stratification of the regional agricultural land into homogeneous spatial units for climate and soil texture, which are then associated with carbon sequestration rates, observed under similar environmental conditions, of the carbon farming practices identified under Action 2. Simulations with the 'C-FARMS method' are possible on a part of the regional agricultural area (approx. 54%).



## Action 5 • Regulatory framework and Carbon certification system.

A **Carbon Farming Certification scheme** has been defined after a public consultation with the stakeholders and according to the EU regulations, including the proposal for a Regulation to create a first EU-wide voluntary framework that would certify high-quality carbon removals, promoted by the EU in November 2022.

It provides procedures and methodology to **certify the net carbon reduction due to the application of carbon farming practices in management of agricultural land and plantation.**



In addition, in order to increase the calculation accuracy and ultimately contribute to the GHG inventory at national level, the project has proposed a system for data collection at farm level based on standardised procedures targeting the main parameters (e.g. soil carbon sampling, trees carbon evaluation etc.) that can be used to determine the carbon evaluation in field due to the carbon farming practices, as well as for the inventory purposes. The two protocols take into consideration the timing, number of sample and sampling methodologies and costs necessary to achieve the optimal tradeoff between representativeness of the sample and operational costs.



## Action 6 • Evaluation of the application potential of IT tools and development of a prototype demonstrator web application for the management of Carbon Farming.

**Aim of the action was to review a selection of existing IT Tools for farm management in order to**

**assess their potential and gaps in the application of Carbon Farming practices.** A total of 116 tools relative to “Management for sustainability of agricultural landscapes” have been identified and classified.

The main output of this action is a public **web repository of selected IT Tools that all users/farmers can access** (available for consulting in the download section of the website <https://c-farms.eu/it/news/>); it supports the increase in the knowledge of the state of the art of tools that could raise awareness and influence the adoption of mitigation practices; the identification of the gaps in the existing instruments could guide further development and improvement of ad-hoc tools and give a contribution for their adoption.

In addition, the web application of the C-FARMS Carbon Farming Simulator was developed, a prototype of a geo-spatial information system that allows users to simulate scenarios on the potential for carbon sequestration and/or reduction of CO<sub>2</sub> emissions, associated with the adoption of carbon farming practices. The application enables analyses at both farm and regional level, based on the use of preset algorithms defined in Actions A2, A3 and A4 of the project.

C-FARMS web application is available at <https://c-farms.eu/simulator.html>

## Action 7 - Demonstration at Farm and Regional Level

The final Action of the Project summarises the application on field of the achieved results, in three macro sub-activities:

1. Analysis of the **main practices in use in the farm and related carbon emissions/removals**;
2. Assessment of **potential of implementation of carbon farming practices using GIS-Farms tool and application of IT tools**;
3. Comparative **economic impact analysis resulting from the introduction of the sustainable practices analysed in the project**.



## FUTURE SCENARIOS

As a Preparatory project, C-FARMS proposes a **methodology for the creation of a high-resolution demonstrative geospatial information system (GIS-FARMS), to identify the mitigation potential of the agricultural sector and foster the design of a certification system for carbon farming practices application.**

The methodology/system will need to be tested in different contexts and regions to prove its efficacy. Although the resulting system has been designed to be applicable to any region, the results will be tailored on the basis of the data available in the specific agricultural context where the system is developed. The replication of the scheme in other regions/countries will reinforce the methodological approach, thanks to a deep articulation of the farming practices and considering local specific data or institutional arrangements.

The partnership of the project development period will serve as a basis to widen the network and work on these themes at a larger European scale.

## RESOURCES AND DOCUMENTS

### Technical Deliverables

- D1 Report: Different data sources for the farm-level sustainability assessments and High-resolution geographical information system creation (Action 1)
- D2 Report: Quality and quantity of data available for each identified crop/livestock carbon farming practice (Action 2)
- D3 Annex: Elaboration of the on-line questionnaire to selected farms (Action 2)
- D4 Report: Review of the methods and approaches to report emissions factors in living biomass, soil and HWP in tree plantations (Action 3)
- D5 Report: Methods and approaches to create gis-farms and impact of the carbon farming practices (Action 4)
- D6 Report: Feasibility analysis of the sampling framework (Action 5)
- D7 Report: Carbon farming certification scheme (Action 5)
- D7 Report Appendix 1: Certification body accreditation minimum requirements (Action 5)
- D7 Report Appendix 2: Certification activity costs (Action 5)
- D9 Report: Application of specific tools to understand the mitigation performance of the carbon farming practices at both farm and regional level (Action 7)



## Dissemination Materials

- Brochure: Results and recommendations for the application of carbon farming practice in cropland and livestock management (Action 2)
- Brochure: Summary of results. Review of methods and approaches to report emissions factors in living biomass, soil and HWP in tree plantations (Action 3)
- Brochure: Evaluation of the potential of IT tools (Action 6)
- Brochure: The C-Farm methodology for the creation of a new system of Incentives

## For general public

- Online oral presentation by PEFC Italy. 'CARBON FARMING: AN OPPORTUNITY FOR COMPANIES AND FOR THE ENVIRONMENT' organized by Confagricoltura. March 2, 2022;
- University of Tuscia's Sustainable Projects presentation at the Athenaeum. Presentation of the C-FARMS Project. October 5, 2022;
- Poster presentation by CREA. "Analisi tecnico-economica per l'adozione di pratiche di carbon-farming in pioppicoltura". Dissemination event entitled: POPLAR FARMING RESILIENT TO CLIMATE CHANGE. Casale Monferrato (AL), July 7, 2023.

To facilitate the understanding of "Carbon Farming" for the general public, including vocational and secondary school students and teachers, a "**Carbon Farming Alphabet**" was created and has been made available in the form of a leaflet (it is also downloadable from the [C-FARMS website](#)).

The project was presented to general public during, for example, the Food&Science Festival, held in Mantua both in 2022 and 2023 editions and during the 12th AIEAA Conference "Guns, Germs and Climate: Food security and Food Systems in a Risky World", held in Milan in June 2023. Another document produced for the dissemination of the project is the brochure, printed and distributed in various dissemination events as well as at the final project conference held on July 18 in Rome.

**In order to further expand the dissemination of the project, an official YouTube channel has been opened in which videos of project dissemination, participation in events as well as live streaming of the project final conference have been uploaded, the link to the YouTube channel is: <https://www.youtube.com/@C-FARMS>.**



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