AgroEcology_Italy: Reducing GHG Emissions and Increasing Carbon Sequestration in Italian Agriculture

Monitoring Report

Summary

The project, "AgroEcology_Italy" targets the transformation of Italian agriculture towards sustainability by implementing agroecology and agroforestry methods aimed at reducing greenhouse emissions and boosting carbon sequestration. Utilizing methodologies from C-Farms, Verra's VM0042, and CDM's AR-AMS0007. This report spans 67 farms across 1474.89 hectares, leveraging the RothC model to assess soil carbon dynamics and validate regenerative agriculture's environmental benefits through peer-reviewed studies, extensive databases, and original data collection, ensuring a scientifically robust methodology for enhancing sustainable agricultural practices.

Basic Information	
ID of project	ICR-48
Project Name	AgroEcology_Italy: Reducing GHG Emissions and Increasing Carbon Sequestration in Italian Agriculture
Project Proponent	Alberami SRL Società Benefit
Representative	Mr. Francesco Musardo, CEO, f.musardo@alberami.it, +39 0832 1827 840 | +39 351 821 4474 Dr. Edivando Vitor do Couto, Head of Carbon Projects and MRV, e.couto@alberami.it, +49 176 62870337
Statement by the Project Proponent	The Project Proponent states he is responsible for the preparation and fair presentation of the Monitoring Report and all accompanying documentation provided.
Version number	3.1
Monitoring Report prepared by	Dr. Edivando Vitor do Couto, e.couto@alberami.it, +49 176 62870337 MSc. Francesco Mursardo, f.musardo@alberami.it , +39 329 822 1835 Dr. Matheus Baumgartner, matheustbs@gmail.com, +55 45 99344025 Dr. Celso H. L. Silva Junior, celsohlsj@gmail.com, +55 98 991105757
Monitoring period	01/01/2022 to 31/12/2023
Criteria for verification	☐ ICR requirement document v.4 ☒ ICR requirement document v.5 ☒ ISO 14064-2 ☒ Other The methodologies C-Farms, VM0042, and the CDM's AR-AMS0007 serve as supporting tools to demonstrate conformity to the established criteria.
Sectoral scope of project activity	14 Agriculture 15 Afforestation and Reforestation
Grouped project	☒ Yes ☐ No
Methodology(ies) applied and version number	The C-Farms, Verra's VM0042 methodology, and the CDM's AR-AMS0007 framework are all incorporated into the project's methodological framework, which serves as the project's foundation.
Type (CDR, avoidance, hybrid)	☒ CDR ☐ Avoidance ☐ Hybrid
MRV cycle:	2-years cycle Start date of MRV cycle – 01.01.2022 End date of MRV cycle – 31.12.2023
Estimated annual average GHG emission mitigation (t CO2-e)	1,142,682

Contents

List of Figures

1. Project description

1.1 Purpose and general description of the project

Alberami S.R.L., an Agri-tech start-up based in Lecce, Puglia, Italy, is the driving force behind the "AgroEcology_Italy" project, which aims to transform Italian agriculture by using farming methods that are sustainable and improve carbon sequestration from the atmosphere. This effort seeks to change local agriculture toward agroecology and agroforestry to lower greenhouse gas emissions and increase carbon sequestration. AgroEcology_Italy goal is achieving environmental, economic, and social sustainability. This has been accomplished by encouraging the increasing amount of soil organic matter and reducing the need for synthetic fertilizers and pesticides.

The project's methodological framework is built upon the integration of the C-Farms methodology, Verra's VM0042 methodology, and the CDM's AR-AMS0007 framework. These methodologies collectively serve as the foundational pillars for the project's design and implementation.

For these initial 67 instances, only Verra's VM0042 methodology was applied, specifically utilizing the Approach 01 model. This selective application ensures that the initial phase adheres to the rigorous standards and guidelines set forth by Verra's VM0042, providing a robust and consistent methodological approach for the project's early stages. When assessing reductions in emissions, improving soil carbon sequestration, and putting agroforestry principles into action, these methodologies offer an accurate approach. By conforming to the requirements of the International Carbon Registry and connecting itself with the 2020 LIFE Programmer of the European Commission, the project establishes a high standard for activities aimed at offsetting carbon emissions.

Reducing carbon dioxide emissions, developing carbon sequestration in soil and biomass, empowering farmers and local communities through economic opportunities in the form of carbon credits, and beginning a holistic transformation in the environment are the project's primary objectives. The initiative emphasizes the function that sustainable agricultural practices play as natural carbon reservoirs and promotes sustainable agriculture practices that are superior to conventional approaches in terms of their potential to absorb carbon dioxide.

The baseline scenario provides an overview of the current status of agricultural activities, focusing on the detrimental effects that conventional farming operations have on the amounts of carbon in the soil, biodiversity, and ecosystem services. Considering that there are already 67 farmers participating in the initiative and that there are 1474.89 hectares involved in this verification step. This report exclusively focuses on Approach 1 of Verra's VM0042 methodology, encompassing only those practices that implemented sustainable agricultural practices. Plantations that are already in existence as well as new biodiverse and productive plantations are the focus of activities that are being carried out in various regions of Italy, such as Puglia, Calabria, and Sicily.

This all-encompassing strategy not only seeks to lessen the effects of climate change but also encourages a sustainable transformation in Italian agriculture by supporting techniques that are beneficial to the environment, economically viable, and socially empowering. The project defines a path towards achieving large reductions in carbon emissions, expanding the capacity for carbon sequestration, and contributing to the global effort against climate change. This is accomplished through the utilization of precise methodology that estimates indicate an annual average GHG emission mitigation of 5.14 tCO_2e per hectare per year.

1.2 Project type and sectoral scope

Sectoral scope	14 Afforestation and reforestation 15 Agriculture
Project type	CDR

1.3 Project

☐ Single location/area or installation
☐ Bundled project (multiple locations/areas or installations)
☒ Grouped project (locations/areas or installations added post validation)
☐ Bundled and grouped project.

1.4 Project proponent

Organization Name	Alberami S.R.L. Società Benefit
Role in the project	Project Proponent
Contact person	Francesco Mursardo, MSc
Title	CEO
Address	www.alberami.it - address: Via Padre Bernardo Paoloni, 10 Lecce, 73100, Italy
Telephone	+39 0832 1827 840 | +39 351 821 4474
Email	f.musardo@alberami.it

1.5 Other parties involved in the project

NA

1.6 Location

Address	Grouped Project
County/province	Italy
Region	North-West: Aosta Valley, Liguria, Lombardy, Piedmont; North-East: Emilia-Romagna, Friuli-Venezia Giulia, Trentino-South Tyrol, Veneto; Centre: Lazio, Marche, Tuscany, Umbria; South: Abruzzo, Apulia, Basilicata, Calabria, Campania, Molise; Islands: Sardinia, Sicily.
Geographic location	

Latitude	36° N, 8° E; 36° N, 18° E
Longitude	47° N, 8° E; 47° N, 18° E
Map link	https://www.google.com/maps/d/u/0/edit?mid=1vHTVuqVqc0BZpo3FGBOrPMO5wrFtub8&usp=sharing

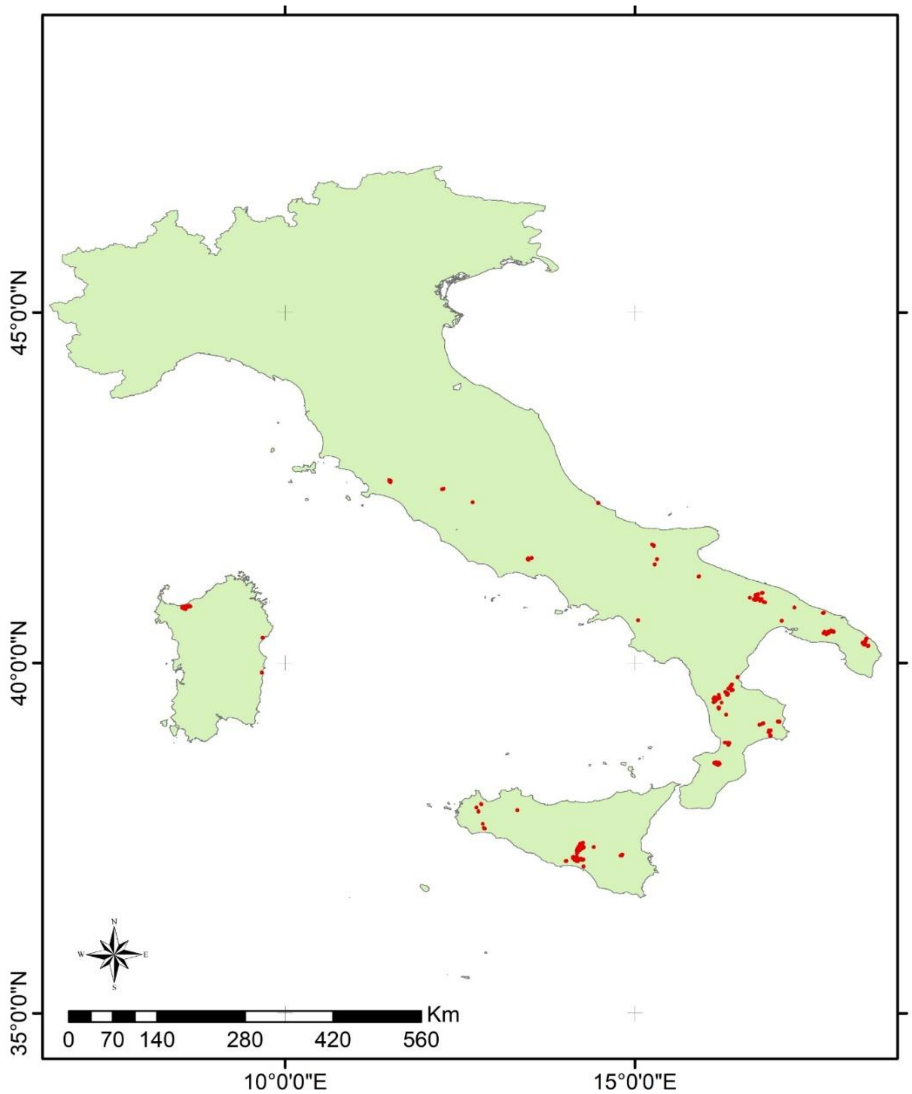

Figure 1 - Italy location map.

1.7 Implementation status of the project

The project commenced its implementation phase on January 1, 2022, marking the beginning of an ambitious endeavor aimed at enhancing soil health and contributing to the mitigation of greenhouse gas (GHG) emissions through regenerative agricultural practices. This initiative, grounded in rigorous scientific methodologies and extensive data analysis, seeks to provide a comprehensive understanding of soil carbon dynamics and their implications for climate change mitigation.

Baseline Scenario

The conditions before the project activity or baseline scenario are the conventional agricultural practices. Since practices before the implementation of the Project vary by farm, if not also by fields, baseline agricultural management practices are identified for each field based on the practices implemented during at least the three years before the implementation of regenerative practices under the project. In the baseline scenario, we can expect that soil carbon levels continue to be reduced due to the depletion of soil organic matter resulting from conventional tillage and lack of organic inputs. Soil erosion and nutrient loss due to the use of synthetic fertilizers and pesticides may also be contributing to a decline in soil quality. Additionally, the baseline scenario would likely result in a loss of biodiversity in the region due to the lack of conservation measures and management of land use. This may also contribute to a decline in ecosystem services provided by the ecosystem, including carbon sequestration, water regulation, and habitat for wildlife.

The baseline period for this project has been established as spanning from 1990 to 2013, relying on the foundational research conducted by Fantappiè et al. (2018), which provided an in-depth analysis of the Italian portion of the Global Soil Organic Carbon Map (GSOCMAP), offering crucial insights into the soil organic carbon stocks across Italy during this period. To complement this baseline, RothC modeling was employed for the subsequent period from 2013 to 2021, adhering to the patterns of land use specified in the data survey on land use types (Appendix 1 folder contains the questionnaire and the results of the questionnaire). This timeline is instrumental in offering a comprehensive reference frame for evaluating the initial state and the progressive development of soil organic carbon (SOC) stocks. See more details in section 6 of this report.

Census survey – Appendix 1.

The survey consisting of a census survey with cadastral was carried out using a pre-established form, called T1 form (Figure 2). This form was required to be filled as a starting point for each property and details the initial state of the project site, regarding factors such as historical land use activities, vegetation cover, soil type, and carbon content estimations, which will serve as a baseline for assessing carbon stock changes during the project's duration.

These forms have been applied to each plot of land use, whose application of practices will be homogeneous; From this procedure, it is concluded that a single contract may be constituted of a varied number of parcels, and consequently, each one of them shall be registered on specific form T1 and a summarization result is got together as a table who is doing what figure 3.

As a demonstration, a property placed in Puglia was selected to illustrate the process, as the following figure. In this case, it was selected to demonstrate the parcels that integrate the property registered under contract number 1000000287 (Figures 4, 5, and 6).

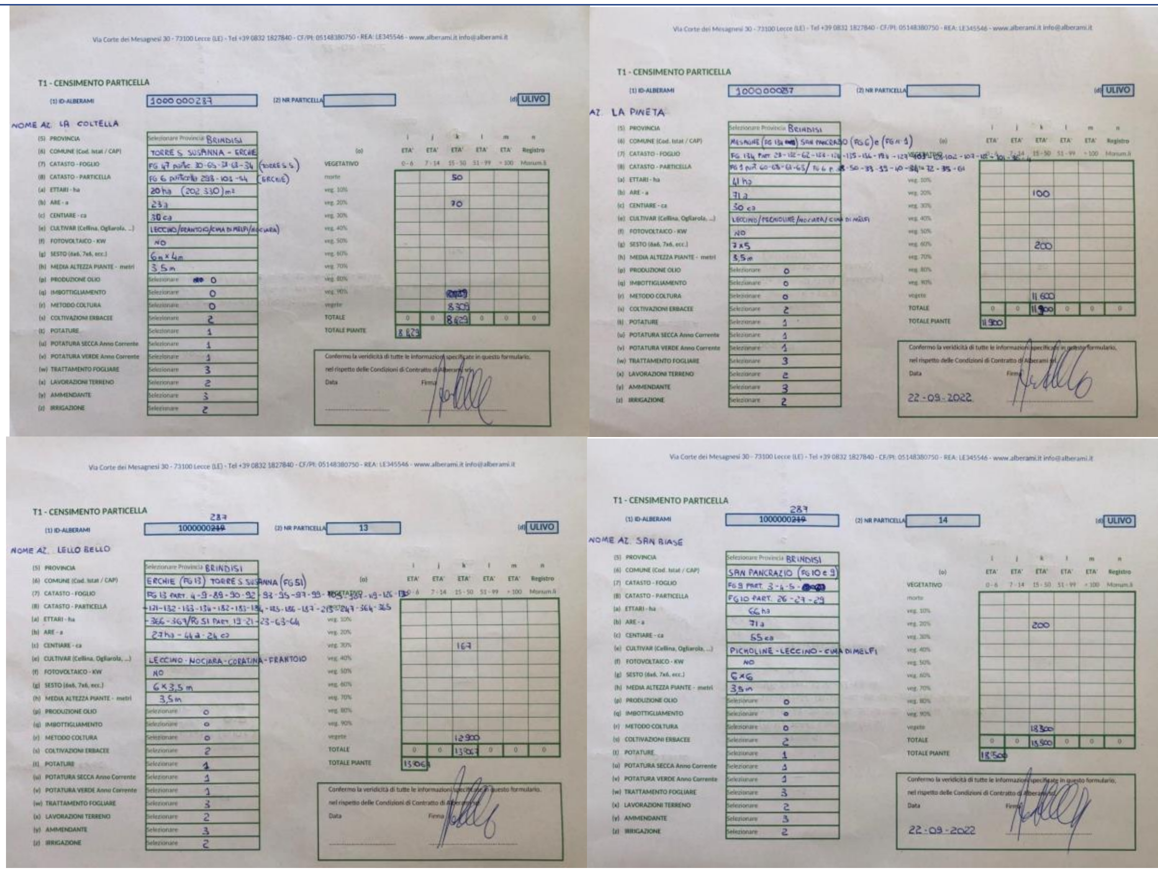

Figure 2 - Example of the data collection questionnaire with farmers.

The data gathered from this form feeds the spreadsheet for controlling the execution of practices by properties which allows a quick understanding of the responsibilities of each contract, as noticeable on the spreadsheet in figure 3.

A	**NEW Practice (implemented because of the project)**
N	Practice **NOT** Applied
P	Practice **Applied through PAC/CAP** financing
Y	Practice **ALREADY APPLIED** Prior to Project Start
I	**Included in Practice 1**

		PRACTICES												
8	**Joining Dat**	**1**	**2**	3	**4**	5	6	**7**	**8**	**9**	**10**	**11**	**12**	**12**
10	1/1/2022	Y	Y	Y	A	A	AA	A	Y	Y	Aa	A3	.	.
11	1/1/2022	N	AA	AA	N	N	AA	N	N	N	N	A3	.	.
12	1/9/2022	N	AA	AA	N	N	AA	N	A	A	Aa	A3	.	.
13	1/14/2022	Y	Y	AA	N	N	AA	Y	Y	Y	Y	A3	.	.
14	1/17/2022	Y	Y	Pa	A	A	AA	Y	Y	Y	Y	Y	.	.
15	1/17/2022	Y	Y	Y	Y	A	AA	A	Y	Y	Y	Y	.	.
16	4/29/2022	Y	Y	Y	N	N	AA	A	Y	Y	Aa	A3	.	.
17	5/5/2022	y	AA	y	A	Y	Y	A	Y	Y	Aa	N	.	.
18	5/12/2022	Y	AA	Pa	A	A	PA	A	Y	Y	Aa	A3	.	.
19	5/14/2022	Y	AA	AA	N	P	PA	A	Y	Y	N	N	.	.
20	5/18/2022	Y	AA	Pa	A	A	PA	A	Y	Y	Aa	A3	.	.
21	5/23/2022	Y	AA	AA	A	A	AA	A	Y	Y	Y	A3	.	.
22	5/28/2022	Y	AA	Pa	A	A	PA	A	Y	Y	Aa	A3	.	.
23	5/31/2022	Y	Y	Y	Y	A	Y	Y	Y	Y	Aa	A3	.	.
24	6/7/2022	Y	AA	N	A	A	PA	A	Y	Y	Aa	A3	.	.
25	6/11/2022	N	AA	AA	N	N	AA	a	y	N	N	N	.	.
26	7/4/2022	A	AA	AA	A	A	AA	A	I	I	Aa	A3	.	.
27	7/4/2022	Y	AA	Pa	A	P	PA	A	Y	Y	Aa	A3	.	.
28	7/11/2022	Y	AA	Pa	A	P	PA	A	Y	Y	Aa	A3	.	.

Figure 3 - Example of the spreadsheet for controlling the execution of practices by properties.

The spreadsheet, in turn, has a reflection in the KML files, which enables the spatialization of information in the form of attributes, thus allowing the recording of the application in each parcel of land under the contract's validity. The following map demonstrates all the properties located at Puglia and highlights the spatial area referred to in contract 1000000287.

Figure 4 - Location of farms from Puglia.

The contract pertains to a single lot or a group of lots owned by the same contractor, upon which a set of practices will be applied according to the spreadsheet for monitoring practices by contract, as the following.

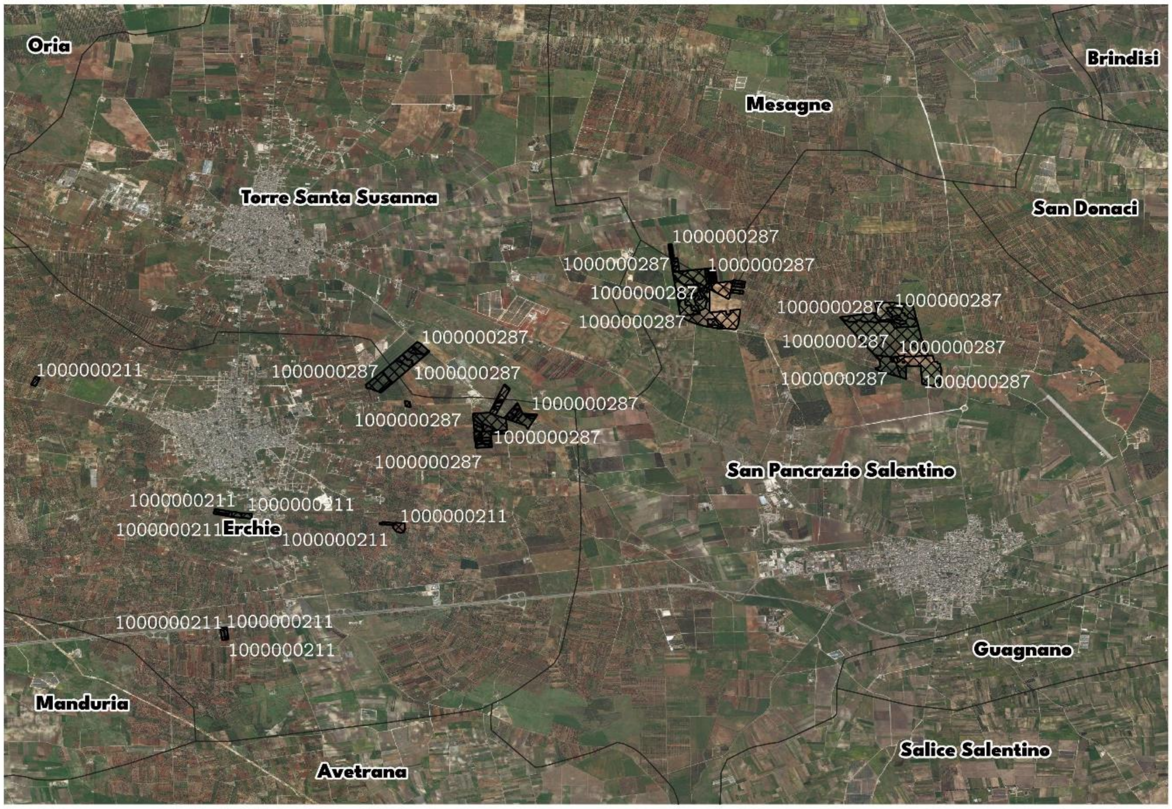

Figure 5 - Example of the location of practices.

Contract 1000000287 regulates the application of a set of practices with a total area of 156.70 ha, all duly referenced concerning their baseline scenario, identifying among the menu of practices, three already applied before the project and 4 practices to be applied additionally.

Figure 6 - Example of the polygons of the farms.

The contract 1000000287 is made up of four distinct parcels that are better represented and more detailed as illustrated in the composite map.

Databases Employed

To validate and enrich the project's analytical framework, several significant databases were utilized:

Topsoil SOC (Figure 7) and SuoliCella500 Soil Databases: These databases give important information about the amount of organic carbon in soil and accurate information about soil depth, clay, and soil classification. This information helps plan ways to store carbon and improve soil health.

Soil Map Vector Database at 1:1,000,000 Scale: Hosted on Zenodo, this database offers comprehensive information on soil typological units and broad soil regions across Italy, essential for understanding the project areas' soil characteristics.

500-meter Grid of Derived Soil Profiles for Italy (SuoliCella500): This database, which is also on Zenodo, gives you a lot of information about the different types of soil in Italy. It does this by analyzing them with neural networks and helping you use regenerative practices correctly.

Carbon Dynamics and Environmental Modeling

The initial phase assumed constant carbon inputs, based on practices already applied on farms before the project's initiation. Subsequently, carbon inputs were tailored for each property according to new practices implemented, leveraging:

TerraClimate and MODIS Data Processing: Techniques for calculating average potential evapotranspiration (PET), mean temperature, and total precipitation, ensuring accurate environmental modeling.
CHIRPS Rainfall Data Processing: Methodology for determining total monthly rainfall, contributing to a comprehensive understanding of environmental factors affecting soil carbon dynamics.
Soil Carbon Modeling and Project Impact
The core analytical tools used by the project to simulate soil carbon turnover and assess the efficacy of regenerative agricultural practices across 67 farms covering 1474.89 hectares are the RothC model and the SoilR application. This rigorous scientific approach facilitates precise forecasting of soil carbon stock fluctuations, establishing a robust basis for validating the environmental benefits of regenerative agriculture in Italy.

GHG Emission Mitigations and Project Performance
Throughout the monitoring period, the project achieved notable success in mitigating a total of 8,044.58 tCO2e. During the implementation phase, there were no changes to the estimated effects or reversals that had been checked. This shows that the project was well managed and made a big difference in reducing climate change by improving soil health and storing carbon.

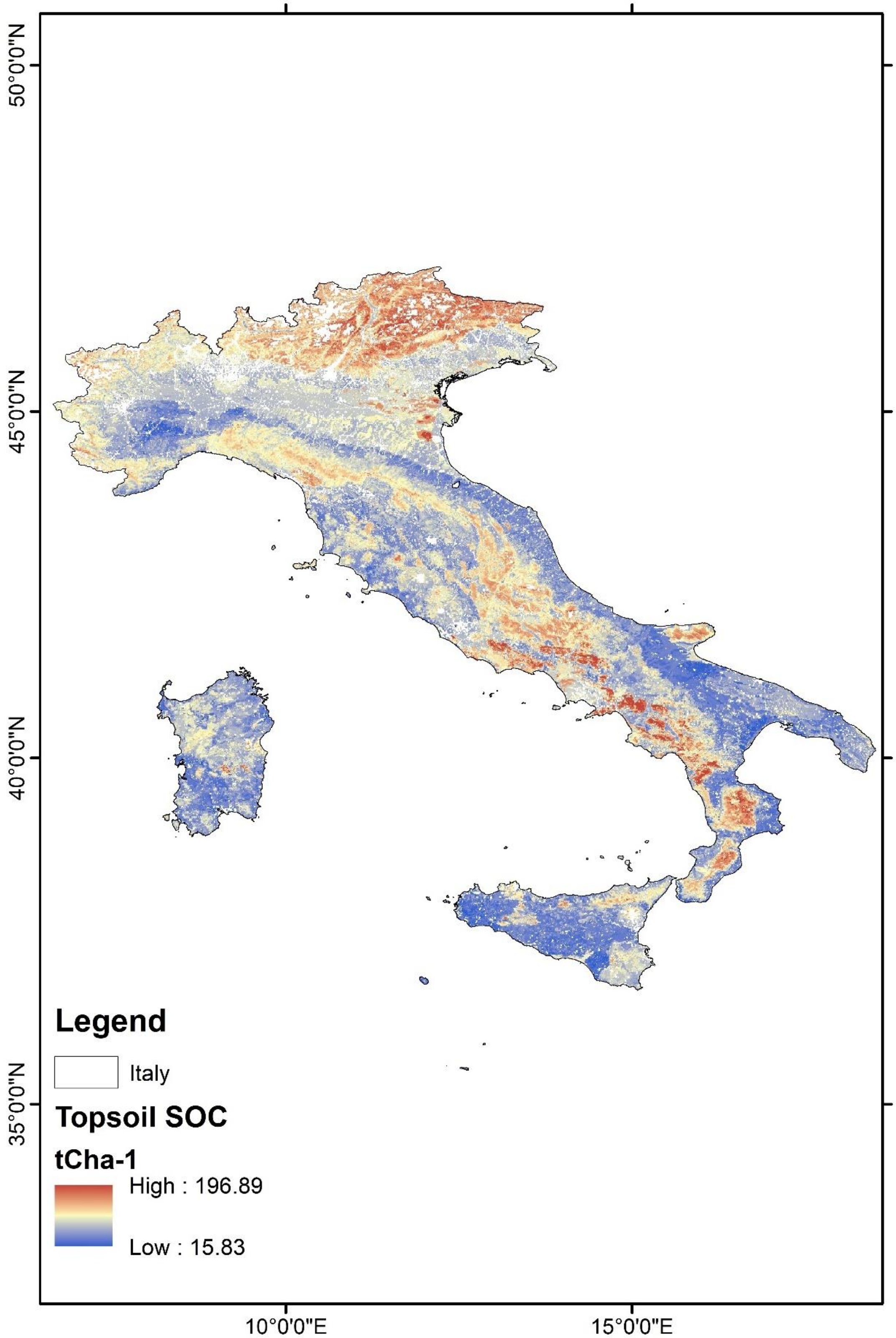

Figure 7 - Global Soil Organic Carbon map (GSOCmap) of Italy. Source Fantappiè et al. (2018).

1.7.1 Project activities

Project Activity Overview

The project activity comprises a suite of sustainable and regenerative Best Agricultural Practices (BAPs), meticulously selected to optimize CO_2 sequestration within both arboreal biomass and soil substrates. These practices are enumerated in Table 1, which outlines the project activities, their names, and definitions.

Table 1. Proposed Best Agricultural Practices (BPAs) under the grouped project activity.

Project Activity N.	Project Activity Name	Mean Δ (tCO2/ha/yr)	Benefits of the practices	References
1	Capillary promotion of organic agriculture management (certified and non-certified).	3.29	- Enhancement in the accumulation of soil organic carbon in the organic agricultural land	1) Farina, R., et al. (2018) 2) Gattinger, A., et al. (2012) 3) Lazzerini, G., et al. (2014) 4) Namirembe, S., et al. (2020) 5) Petersson, T. et al. (2017) 6) Poeplau, C., et al. (2015) 7) Powlson, D. S., et al (2012) 8) Sacco, D., et al. (2015)
2.a	Zero Tillage	2.08	- Enhancement in the accumulation of soil organic carbon in the organic agricultural land	9) Álvaro-Fuentes, J., et al. (2007) 10) Álvaro-Fuentes, J., et al. (2008) 11) Álvaro-Fuentes, J., et al. (2014) 12) Baiamonte, G. et al. (2022) 13) Cillis, D., et al. (2018) 14) Fiorini, A., et al. (2020) 15) Mazzoncini, M., et al. (2011) 16) Troccoli, A., et al. (2022)
2.b	Minimum tillage	1.13	- Enhancement in the accumulation of soil organic carbon in the organic agricultural land	
3.a	Green Cover: spontaneous or sowed vegetation	2.7	Enhancement in the accumulation of soil organic carbon in the organic agricultural land	6) Poeplau, C., et al. (2015) 17) Lal, R. (2018) 18) Sartori, F., et al. (2006) 19) Zhang, K. (2020)
3.b	Use of Cover Crops	1.85	Enhancement in the accumulation of soil organic carbon in the organic agricultural land	5) Petersson, T. et al. (2017) 20) FAO (2021) 21) IPCC (2021)
4	Intercropping	1.1	Enhancement in the accumulation of soil organic carbon in the organic agricultural land	6) Poeplau, C., et al. (2015) 22) Franzluebbers, A. J. (2005) 23) Jian, J., et al. (2020) 24) Locatelli, J. (2020)
5	Farm management with hedges, rows and forest integrated into field crops	4.0	Enhancement in the accumulation of soil organic carbon in the organic agricultural land	25) Francaviglia, R. (2017)

6	Management of woody plantation pruning residue: Soil Conditioner	2.9	Increased in carbon sequestration in the woody perennials	26) Blonska, E. (2017) 27) Galan-Martin, A., et al. (2022) 28) Gomez-Munoz, B., et al. (2016) 29) Knoblauch, C., et al. (2021) 30) Michalopoulos, G., et al. (2020) 31) Smith, P., et al. (2015) 32) Freibauer, A., et al. (2004) 33) Musacchi, S., et al. (2021) 34) Ronga, M., et al. (2008)
7	Application of inorganic natural substances and natural leaf fertilizers (minerals rocks or powder)	1.9	Carbon sequestration as a result of enhanced rock weathering	35) Berge, H. F. M., et al. (2012) 36) Dietzen, C., et al. (2018) 37) Haque, F.; Santos R. M.; Chiang, Y. W. (2020) 38) Kelland, E. M., et al. (2020) 39) Swoboda, P.; Döring, T. F.; Hamer, M. (2022) 40) Thorben, A., et al. (2020)
8	Radical reduction of synthetic fertilizers	1.27	Reduction in N_2O emissions (a potent greenhouse gas)	25) Francaviglia, R., et al. (2017)
9	Radical reduction of pesticides	0.28	Prevention of harmful effects of pesticides on humans	41) Cooper, J., et al. (2016) 42) Krauss, M., et al. (2020) 43) Krauss, M., et al. (2022)
10.a	Recycling of farm's organic matter: Agro-industrial waste	2.05	Increase in soil fertility and increase in essential soil nutrients. Increase in soil carbon stock.	5) Petersson, T. et al. (2017) 44) Bertora, C., et al. (2009) 45) Forte, A.; Fagnano, M.; Fierro, A. (2017) 46) Tomasoni, C., et al. (2009) 47) Maris, S. C., et al. (2021) 48) Morari, F., et al. (2006)
10.b	Recycling of farm's organic matter: Biochar	2.05		
10.c	Recycling of farm's organic matter: Anaerobic Digestate	2.05		
10.d	Recycling of farm's organic matter: Compost	2.05		
10.e	Recycling of farm's organic matter: Farmyard Manure	2.05		

11.a	New Planting: Vine	1.8	Carbon sequestration in aboveground and belowground biomass	5) Petersson, T. et al. (2017) 49) Tommaso, C., et al. (2018) 50) Chiti, T., et al. (2018) 51) Regni, L., et al. (2017)
11.b	New Planting: Orchard	2.6		
11.c	New Planting: Olive Trees (*Olea europaea*)	2.2		
11.d	New Planting: Other Woody Perennial Species	1.5		
12	Cropland or conversion of cropland with annual crops to grassland/pastureland or permanent crops	4.69	Increase in Soil carbon sequestration	5) Petersson, T. et al. (2017) 25) Francaviglia, R., et al. (2017)
13.a	Improved Crop Rotations	0.63	Increase in Soil carbon sequestration	5) Petersson, T. et al. (2017) 25) Francaviglia, R., et al. (2017)
13.b	Crop Rotations: Industrial Hemp	12	Increase in Soil carbon sequestration and Carbon sequestration in aboveground biomass	52) European Commission (2024) 53) Desta et al., 2020 54) Wolske et al., 2019; 55) Suter et al., 2019 56) Amaducci et al., 2015; 57) Bouloc et al., 2022 58) Hartl & Hess, 2024; 59) Taylor & Williams, 2022

Project MRV Organogram and MRV Personnel Competence

The Project MRV (Monitoring, Reporting, and Verification) Organogram (Figure 8) has been structured representation of the roles and hierarchy within a project focused on environmental or sustainability metrics. It visually outlines the organizational structure and details the key personnel involved in the MRV process of the project activity. The organogram helps in understanding how different roles interact and contribute to the monitoring, reporting, and verification aspects of the project.

Name of the Expert for Monitoring, Reporting, and Verification (MRV) of the Project Activity

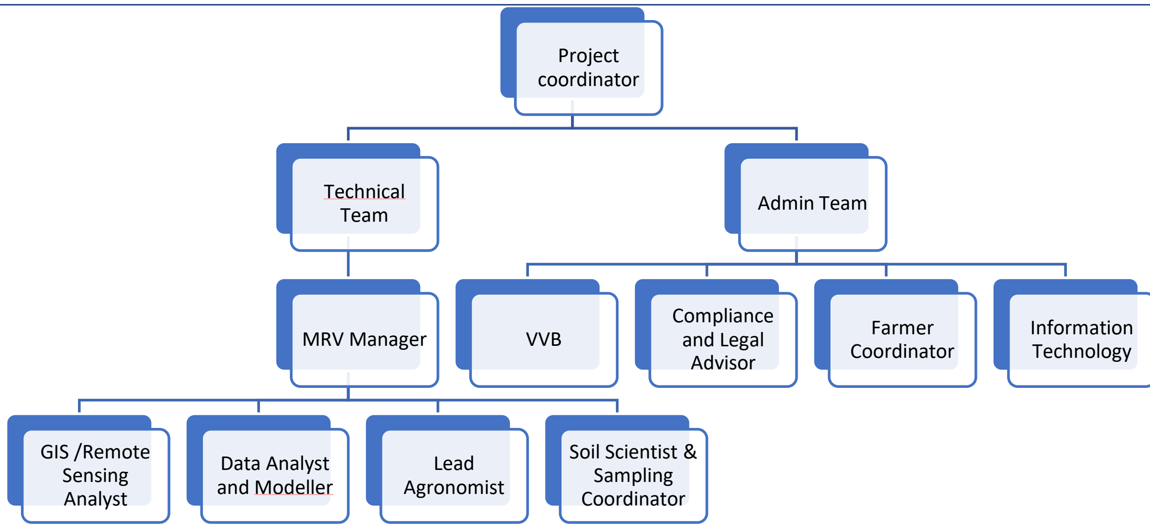

Figure 8 - Organigram of the Monitoring, Reporting and Verification (MRV) of the Project Activity.

#	Name of the Expert	Qualification	Role in the Monitoring, Reporting and Verification of the Project Activity
1	Francesco Musardo	MSc	CEO and Project Director
2	Dr. Edivando do Couto	PhD	Project Coordinator and MRV Manager
3	Dr. Matheus Baumgartner	PhD	Data Analyst and Modeler
4	Dr. Thomas Vatrano	PhD	Lead Agronomist
5	Valentina Marrone	BA (Hons)	Agronomist & Farmer Coordinator
6	Dr. Celso Silva	PhD	GIS / Remote Sensing Analyst
7	Davide Manelli	Lawyer	Compliance and Legal Advisor
8	Validation and Verification Body	VVB	External Auditor or Verifier

1.7.1.1 Deviations from project description

There were no deviations during the Monitoring Period.

1.7.1.2 Reassessment of baseline scenario

Did the project undergo baseline reassessment during the monitoring period?

☐ Yes

☒ No

1.7.1.3 Grouped projects

1.7.1.3.1 Eligibility criteria for grouped project

The AgroEcology_Italy project qualifies as an example of Grouped Projects due to its integrated and multifaceted approach to promoting sustainable and regenerative agricultural practices aimed at reducing and removal GHG. The project's structure is designed to cluster multiple activities under common management, which is fundamental to the concept of grouped projects. Here are the key points justifying the classification of the AgroEcology_Italy project as a grouped project:

i. Implementation of Multiple Best Agricultural Practices (BAPs): The project requires farmers to select and implement at least three BAPs that have not been previously adopted on their lands. This approach not only encourages the adoption of sustainable and regenerative practices but also allows the combination of multiple emission reduction activities under a single initiative.

ii. Common Management and Collective Monitoring: The management structure of the AgroEcology_Italy project facilitates the coordination and collective monitoring of the activities implemented by participating farmers. Through signing contracts with Alberami, farmers commit to implementing selected BAPs, monitoring, and reporting progress, and ensuring that all activities follow the same methodology and can be collectively monitored.

iii. Technical Assessment and Ongoing Support: The technical assessment process to verify the eligibility and feasibility of the chosen BAPs, including technical visits to the properties, ensures that all implemented activities are aligned with the project's objectives. Additionally, the project provides technical training, resources, and financial incentives to support the effective implementation of practices, facilitating unified activity management.

iv. Use of Advanced Technologies for Monitoring and Evaluation: The application of advanced technologies for data collection and analysis strengthens the project's ability to monitor and evaluate activities collectively, allowing for continuous adjustments and improvements in practices and farmer engagement. This is essential for grouped projects, where collective monitoring of reduced emissions and environmental, economic, and social benefits is crucial.

v. Annual Reporting and Carbon Credits Generation: Documenting outcomes in annual reports and independent verification of these results enable the generation of carbon credits. This aspect demonstrates the project's ability to quantify the environmental benefits of grouped activities, a key element for grouped projects aiming to offset greenhouse gas emissions.

The structure of the AgroEcology_Italy project, with its integrated approach to implementing sustainable and regenerative agricultural practices, collective monitoring of activities, and generation of quantifiable benefits, aligns perfectly with the criteria for grouped projects. The project not only promotes emission reduction-removals through common management but also provides a model for the collective monitoring and evaluation of activities, essential for the success and sustainability of grouped initiatives in the context of climate change mitigation.

Justification and Confirmation of Project Instance 67 Meeting Eligibility Criteria

The first project instance of the AgroEcology_Italy project, referred to as project instance 67, has demonstrably met all outlined eligibility criteria. This confirmation is based on several critical components detailed within the project documentation.

Implementation of Multiple Best Agricultural Practices (BAPs)
Farmers participating in project instance 67 have been required to implement at least three new BAPs that had not been previously used on their lands. This ensures the adoption of innovative and sustainable agricultural practices specifically aimed at reducing greenhouse gas (GHG) emissions and enhancing carbon sequestration.

The adoption of these practices aligns with the project's goals of promoting sustainable agriculture and environmental stewardship.

Common Management and Collective Monitoring
The project is structured under a common management system where participating farmers enter into agreements with Alberami SRL. These agreements outline the responsibilities of both parties, including detailed plans for implementing BAPs, processes for monitoring progress, and regular reporting requirements. This collective management approach ensures that all project activities are coordinated and monitored consistently across all participating farms, facilitating effective oversight and accountability.

Technical Assessment and Ongoing Support
Prior to their inclusion in the project, each application underwent a rigorous technical assessment to verify the feasibility and suitability of the selected BAPs. This included on-site visits by the technical team to ensure that the practices were appropriate for the specific conditions of each farm. Additionally, the project provided extensive training, resources, and financial incentives to support the implementation of these practices, ensuring that farmers had the necessary tools and knowledge to succeed.

Use of Advanced Technologies for Monitoring and Evaluation
Advanced technologies have been integral to the monitoring and evaluation processes of project instance 67. Data collection and analysis have been conducted using cutting-edge tools to provide real-time monitoring capabilities and facilitate necessary adjustments. This technological approach ensures that the project can accurately measure the impact of the implemented practices, thus verifying their effectiveness in achieving the project's sustainability goals. The results from these monitoring activities are meticulously documented in annual reports, which are independently verified to maintain transparency and credibility.

Annual Reporting and Carbon Credits Generation
The project has established a robust reporting framework where outcomes are documented in annual reports. These reports undergo independent verification to ensure accuracy and reliability. This verification process is crucial for the generation of carbon credits, which serve as a quantifiable measure of the project's environmental benefits. The generation of carbon credits not only underscores the project's success in reducing GHG emissions but also provides financial incentives for continued sustainable practices.

Project instance 67 of the AgroEcology_Italy initiative has clearly demonstrated compliance with all outlined eligibility criteria. Through the strategic implementation of sustainable agricultural practices, robust management and monitoring frameworks, technical assessments, and the use of advanced technologies, the project has successfully met its objectives. The comprehensive documentation and independent verification processes further confirm that project instance 67 aligns with the highest standards of environmental sustainability and accountability. This first instance sets a solid foundation for the continued success and expansion of the AgroEcology_Italy project, contributing significantly to the goals of reducing greenhouse gas emissions and promoting sustainable agriculture in Italy.

1.7.1.3.2 New project instances

No project instances have been added other than 67.

1.8 Double counting, issuance and claiming

Neither has the project been registered, nor is it currently in the process of registering under any other greenhouse gas programs.

1.8.1 Other registration and double issuance

Is the project registered or intends to be registered with another GHG program?

☐ Yes,

☒ No

Has the project been rejected by another GHG program

☐ Yes,

☒ No

1.8.2 Double claiming and other instruments

Are the project activities also included in a GHG emissions trading program or subject to binding emission limit?

☐ Yes,

☒ No

Has the project activity applied for, received, or is planning to receive instruments from another GHG-related environmental crediting system, e.g. IREC or Guarantees of Origin.

☐ Yes,

☒ No

Do project activities affect GHG emissions accounted for within a value chain (goods/service, i.e. scope 3 emissions and the project proponent or Authorized representative a buyer or a seller of such goods/services?

☐ Yes,

☒ No

1.9 Other benefits

SDG impacts during the monitoring period See the questionnaire and the results of the questionnaire in the appendix 2 folder				
SDG target	Indicator (text from the SDG indicator)	Net impact (implemented activities to increase or decrease)	Current contributions	Lifetime contributions
1. No poverty				
1.1	By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day.	Positive. The project has contributed to a noticeable improvement in reducing extreme poverty.	The project has made a substantial impact in improving the financial resilience of small-scale farmers in Italy. Although extreme poverty isn't a widespread issue in this context, the project has addressed the significant income variability that these farmers often face. By introducing sustainable and profitable farming practices, along with access to new income streams like carbon credits, the project has contributed to stabilizing and potentially increasing their earnings. This initiative helps mitigate the economic vulnerabilities inherent in small-scale farming.	The project`s long-term goal is to establish a sustainable and stable economic foundation for small-scale farmers in Italy. By continually supporting and advancing sustainable agricultural practices and facilitating access to financial incentives like carbon credits, the project aims to ensure that farming remains a viable and stable livelihood. This approach is expected to significantly reduce the susceptibility of these farmers to economic fluctuations and enhance their overall economic well-being, contributing to the broader objective of reducing poverty in all its dimensions.
1.2	By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions.	Positive. The project has effectively contributed to reducing multi-dimensional poverty among participants.	The project has notably enhanced economic stability among participant farmers, leading to greater resilience against poverty. This has been achieved through diversifying income sources, particularly by integrating carbon credit earnings and promoting more profitable sustainable farming practice.	The project is poised to contribute to a long-term reduction in multi-dimensional poverty. This will be achieved through the continued economic empowerment of farmers, fostered by the sustained adoption of regenerative practices and ongoing skill development. Over time, these efforts will enhance the overall quality of life for farmers and their

				communities, leading to lasting changes that extend beyond financial stability to encompass improved health, education, and social well-being, in line with the comprehensive goals of reducing poverty in all its dimensions.
2. Zero hunger				
2.3	By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.	Highly Positive. The project has significantly improved agricultural productivity and income for small-scale producers.	The project has led to a significant boost in agricultural productivity and income for small-scale producers, a remarkable achievement given the typically expected transitional period in adopting new farming practices. Within just two years, participating farmers have reported early positive outcomes, underscoring the effectiveness of the sustainable and regenerative farming practices introduced by the project. These practices have not only increased crop yields but have also contributed to the overall financial stability of the farmers.	The early successes of the project bode well for the long-term enhancement of small-scale producer`s; livelihoods. This positive trend is anticipated to continue, with potential for further growth in income and productivity as the farmers become more adept with and refine the sustainable practices. The project is poised to sustainably double productivity and income for small-scale food producers, ensuring a more prosperous and secure future for them and their communities.
2.4	By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and	Highly Positive. The project is significantly contributing to the sustainability and resilience of food production systems.	The project`s implementation of regenerative agriculture has been instrumental in transforming the food production systems into more sustainable and resilient models. This includes practices like crop diversification, soil health improvement, and efficient water use, all contributing to enhanced productivity while minimizing environmental impact.	Ongoing commitment to sustainable agriculture, ensuring long-term food security and ecosystem health. The widespread adoption of organic and regenerative practices is expected to lead to enduring improvements in the sustainability and resilience of food production systems. The high rate of organic certification and adoption among participants indicates

	that progressively improve land and soil quality.		Over 95% of farmers currently enrolled onto the program are organic-certified, in the process of becoming certified or adopting organic farming practices.	a long-term commitment to environmentally responsible farming, which will contribute to food security, ecosystem health, and climate resilience well into the future.
8. Decent work and economic growth				
8.2	Achieve higher levels of economic productivity through diversification, technological upgrading, and innovation, including through a focus on high-value added and labor-intensive sectors	Positive. The project has contributed to enhanced economic productivity through innovative agricultural practices.	The project has fostered increased economic productivity by introducing innovative agricultural practices that diversify farming activities. Through the adoption of regenerative farming methods and the integration of agroforestry, farmers are achieving higher yields and better soil health, which contributes to greater economic output and efficiency.	The introduction and continuous improvement of regenerative practices and agroforestry are expected to provide lasting economic benefits. By promoting agricultural diversity and technological innovation, the project supports the long-term growth of economic productivity. As farmers adapt and refine these practices, there will likely be a ripple effect that bolsters the sustainability and resilience of farming systems. This transformation is expected to generate enduring, positive changes within the agricultural sector, contributing to the vitality of the broader economy and supporting a shift towards more sustainable economic development.
8.3	Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized	Positive. The project supports the development of policies favoring sustainable agricultural practices and rural development.	The project has advanced the development and implementation of policies that incentivise sustainable agriculture, which has been instrumental in fostering a supportive environment for rural development. It has encouraged the uptake of practices that contribute to economic	The project`s financial incentives and expert guidance facilitate the creation of decent jobs and support entrepreneurship in the agricultural sector. In the long term, the project is set to reinforce a policy framework that consistently supports sustainable

	enterprises, including through access to financial services.		empowerment and environmental stewardship among the agricultural community.	agricultural innovations. This will help to solidify a foundation for enduring rural prosperity, environmental health, and community resilience, further catalyzing socio-economic development aligned with sustainable practices.
8.5	By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value	Moderate. The project has made some progress in improving employment quality within the agricultural sector.	The project has contributed to improvements in employment quality by promoting fair labor practices and investing in skills development. These efforts have begun to elevate job satisfaction and security for agricultural workers, setting a precedent for quality employment standards.	The ongoing commitment to sustainable agricultural practices is expected to drive continuous improvements in employment conditions. By fostering a stable and skilled workforce, the project aims to secure lifelong livelihoods for agricultural workers, contributing to broader economic stability and prosperity.
9. Industry, innovation, and infrastructure				
9.3	Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets	Positive. The project has significantly enhanced access to financial services for small-scale agricultural enterprises.	The initiative has successfully broadened access to financial services for small-scale farmers, enabling them to invest in sustainable agriculture. This has included providing easier access to credit and financial instruments that facilitate the adoption of regenerative practices and technological upgrades.	The project`s commitment to financial inclusivity is poised to have lasting effects, ensuring that small agricultural businesses can continually access the capital needed for innovation and growth. This sustained financial empowerment is integral to building a resilient agricultural sector that can adapt to market and environmental changes.
9.5	Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation	Highly Positive. The project has substantially contributed to the integration of innovative technologies in agriculture and the creation of highly skilled research and development roles.	The project has not only integrated innovative farming technologies but also recruited a team of highly skilled professionals, including experts in Agriculture 4.0, remote sensing, data science, and IT with blockchain	With a focus on continuous improvement and adaptation, the project is set to drive long-term technological progression within the agricultural sector. This commitment to research and technological

	and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending		expertise. This skilled workforce is enhancing the efficiency and productivity of agricultural practices and fostering a knowledge-based environment within the sector.	development is expected to meet future environmental challenges and market demands, fostering a dynamic and progressive agricultural industry. The influx of specialized expertise and the adoption of advanced technologies pave the way for continuous agricultural innovation. The project`s environment of innovation not only benefits current practices but also attracts additional talent, driving further advancements. This progressive approach promises to evolve with and adapt to future environmental and market demands, cementing a legacy of technological leadership in agriculture.
12. Responsible consumption and production				
12.2	By 2030, achieve the sustainable management and efficient use of natural resources	Highly Positive. The project significantly promotes the efficient and sustainable use of natural resources.	The project has effectively implemented regenerative agricultural practices that significantly improve resource efficiency. These practices include optimized water usage, soil fertility enhancement, and reduced reliance on non-renewable inputs. The initiative also focuses on minimizing environmental impact through eco-friendly farming techniques, which are instrumental in promoting sustainable resource management within the agricultural community.	The project`s long-term vision is rooted in the continuous implementation and refinement of regenerative practices, contributing to the sustainable management of natural resources. These efforts are aimed at ensuring ecological balance, preserving biodiversity, and maintaining resource availability for future generations. Through educational programs, community engagement, and policy advocacy, the project seeks to instill a legacy of resource stewardship that upholds

				the principles of sustainability well beyond its immediate scope.
12.4	By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.	Highly Positive. The project has been effective in promoting environmentally sound practices in chemical and waste management.	The project has successfully fostered a reduction in the use of harmful agricultural chemicals by advocating for and facilitating the transition to natural farming alternatives. With the majority of participant farmers practicing or transitioning to organic farming, there has been a marked decrease in the chemical footprint on the land, leading to improved soil health and reduced environmental contamination.	The dedication to organic farming principles among the project`s participants lays the groundwork for a lasting impact on chemical and waste management in agriculture. This commitment is expected to sustain a minimal chemical and waste footprint, as organic practices become more deeply embedded in the agricultural sector. The project’s influence promises to extend beyond its immediate circle, setting industry-wide standards for the environmentally sound management of chemicals and waste.
12.8	By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.	Highly Positive. The project plays a crucial role in educating and informing people about sustainable development.	The project has established a robust information-sharing platform that actively disseminates knowledge on sustainable practices within the farming community. This includes providing access to the latest research, best practices in sustainable agriculture, and the benefits of adopting these methods. Digital content, workshops, training sessions, and on-the-ground support have all played a part in enhancing farmers’; understanding and application of sustainability principles.	By ingraining the importance of sustainable development in the current generation of farmers, the project is cultivating a legacy of environmental stewardship. The ongoing educational initiatives are designed to evolve with emerging sustainable technologies and practices, ensuring that the farming community remains at the forefront of sustainable development. This commitment is key to fostering a resilient agricultural sector that can contribute to the well-being of society and the planet for years to come.
13. Climate action				

13.1	Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.	Positive. The project has effectively enhanced the resilience of agricultural practices to climate change.	The project has notably increased the resilience of agricultural practices to climate-related hazards through the adoption of regenerative farming techniques. This includes practices like improved soil management, water conservation, and biodiversity enhancement, which have been effective in mitigating the impacts of climate variability. Farmer feedback underscores the success of these methods in creating more resilient farming systems.	The long-term strategy of the project is focused on continually strengthening the adaptability of agricultural practices to meet the challenges posed by a changing climate. This includes not only maintaining but also evolving regenerative practices and technologies to anticipate future environmental conditions. The project's dedication to climate resilience aims to ensure that agricultural systems are robust and sustainable, capable of withstanding climate fluctuations and contributing to overall environmental health.
13.3	Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	Highly Positive. The project is instrumental in raising awareness and education about climate change.	The project has played a pivotal role in increasing the awareness and understanding of climate change issues among farmers. Through various initiatives, it has actively disseminated information about the impacts of climate change and effective mitigation strategies. Farmers have been introduced to methods for reducing their carbon footprint and adapting to climate variations, which includes practices like water conservation, soil management, and the use of renewable energy sources in agriculture.	The project is dedicated to developing and enhancing comprehensive education and training programs focused on climate change adaptation and mitigation. These programs aim to empower not only the current generation of farmers but also future generations, instilling a culture of environmental consciousness and proactive response to climate challenges. The continuous evolution of these educational initiatives ensures that they remain relevant and effective in equipping the agricultural community to face the ongoing and future impacts of climate change.
15. Life on land				
15.5	Take urgent and significant action to reduce the degradation of natural habitats, halt the loss	Highly Positive. The project has a significant positive impact on habitat conservation and biodiversity.	The project has made a considerable impact on habitat conservation and biodiversity enhancement, primarily	The long-term focus of the project is to continue and expand upon these agroforestry practices. By consistently

	of biodiversity and, by 2020, protect and prevent the extinction of threatened species		through the implementation of key agroforestry practices. These practices include the protection and re-creation of natural landscapes within agricultural areas, the establishment of buffer strips and windbreaks to protect soil and water resources, and the introduction of biodiversity in traditional Mediterranean monocultures. This approach has not only improved habitat quality but also contributed to the overall health of the ecosystem.	implementing and promoting measures like natural landscape preservation, the creation of ecological buffer zones, and the integration of diverse species into agricultural systems, the project aims to enhance biodiversity and ecosystem health substantially. This ongoing commitment will contribute to the reduction of natural habitat degradation and promote a balanced coexistence of agriculture with the natural environment.
17. Partnership for the goals				
17.6	Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism Indicators	Implementation of a North-South technology transfer involving Sicrex Sagl, a Swiss company, and Alberami, utilizing blockchain technology for the exchange of carbon dioxide removal credits. The use of blockchain technology in this context significantly increases transparency and reliability in the exchange of carbon dioxide removal credits. This not only fosters trust between the Northern and Southern entities but also sets a precedent for similar collaborations. The initiative contributes to environmental sustainability by promoting carbon dioxide removal, a crucial aspect in the fight against climate change. Increase in the efficiency and security of environmental credit transactions,	This project exemplifies North-South cooperation, strengthening ties between Swiss technology and Alberami`s local knowledge and implementation capabilities. It serves as a model for other regions looking to engage in similar technology transfers, thereby enhancing international cooperation in environmental sustainability. Alberami gains access to advanced Swiss blockchain technology, enhancing its technological base and innovation capacity. The Swiss company, in turn, benefits from insights into local conditions and requirements in Alberami`s region, potentially informing future innovations.	The project has the potential to create a long-lasting impact by establishing a robust system for carbon credit exchange that can be replicated and scaled in other regions. Over its lifetime, the initiative could significantly contribute to global carbon reduction efforts, playing a vital role in achieving climate change targets. The continuous exchange of knowledge and technology between the Swiss company and Alberami will build capacity in both entities, leading to ongoing improvements and innovations in their respective fields. The project could also serve as a case study or blueprint for future North-South and South-South technology transfers, contributing to the global knowledge base in this area.

		leading to potentially higher volumes of carbon credit exchanges. Decrease in the risks associated with fraud or mismanagement in the carbon credit market, thanks to the inherent security features of blockchain technology.		

1.10 Host country attestation

☐ Host country attestation

☒ No host country attestation

1.11 Additional information

No relevant information to add.

1.11.1 Confidential/sensitive information

Information pertaining to the technology transfer between Swiss Sagl and the PP is being kept confidential due to it being protected by NDA as it contains trade secrets and patented information belonging to a third party and it is not otherwise publicly available.

The technology does not relate to the determination of the baseline scenario, project boundary, demonstration of additionality, and estimation and monitoring of GHG emission reductions and removals (including operational and capital expenditures).

2. Crediting

2.1 Project start date

Project start date	01-01-2022

2.2 Expected operational lifetime or termination date

01-01-2022 to 31-12-2066 - 45 years

2.3 Crediting period

The initial crediting period for this project is 15 years, starting from January 1, 2022, and ending on December 31, 2036. This project is designed with a renewable nature, allowing for a total potential crediting period of 45 years. Following the end of the first 15-year period, the project can be renewed for two additional periods of 15 years each, subject to validation and verification processes.

Start date of crediting	01/01/2022
Crediting period	☐ Five years, renewable twice. ☐ Ten years, fixed. ☒ Fifteen years, renewable twice (CDR only). ☐ Other, provide information on how that conforms with ICR requirement document.

2.4 Calendar year of crediting

Calendar year of crediting	Estimated ER total
	Agroecology_Italy Project
1 January 2022 to 31 December 2022	1,899
1 January 2023 to 31 December 2023	6,146
1 January 2024 to 31 December 2024	162,185
1 January 2025 to 31 December 2025	324,370
1 January 2026 to 31 December 2026	486,555
1 January 2027 to 31 December 2027	648,740

1 January 2028 to 31 December 2028	810,925
1 January 2029 to 31 December 2029	973,110
1 January 2030 to 31 December 2030	1,297,480
1 January 2031 to 31 December 2031	1,297,480
1 January 2032 to 31 December 2032	1,297,480
1 January 2033 to 31 December 2033	1,297,480
1 January 2034 to 31 December 2034	1,297,480
1 January 2035 to 31 December 2035	1,297,480
1 January 2036 to 31 December 2036	1,297,480
1 January 2037 to 31 December 2037	1,297,480
1 January 2038 to 31 December 2038	1,297,480
1 January 2039 to 31 December 2039	1,297,480
1 January 2040 to 31 December 2040	1,297,480
1 January 2041 to 31 December 2041	1,297,480
1 January 2042 to 31 December 2042	1,297,480
1 January 2043 to 31 December 2043	1,297,480
1 January 2044 to 31 December 2044	1,297,480
1 January 2045 to 31 December 2045	1,297,480
1 January 2046 to 31 December 2046	1,297,480
1 January 2047 to 31 December 2047	1,297,480
1 January 2048 to 31 December 2048	1,297,480
1 January 2049 to 31 December 2049	1,297,480
1 January 2050 to 31 December 2050	1,297,480
1 January 2051 to 31 December 2051	1,297,480
1 January 2052 to 31 December 2052	1,297,480

1 January 2053 to 31 December 2053	1,297,480
1 January 2054 to 31 December 2054	1,297,480
1 January 2055 to 31 December 2055	1,297,480
1 January 2056 to 31 December 2056	1,297,480
1 January 2057 to 31 December 2057	1,297,480
1 January 2058 to 31 December 2058	1,297,480
1 January 2059 to 31 December 2059	1,297,480
1 January 2060 to 31 December 2060	1,297,480
1 January 2061 to 31 December 2061	1,297,480
1 January 2062 to 31 December 2062	1,297,480
1 January 2063 to 31 December 2063	1,297,480
1 January 2064 to 31 December 2064	1,297,480
1 January 2065 to 31 December 2065	1,297,480
1 January 2066 to 31 December 2066	1,297,480
Total Estimated Net Carbon Removal (tCO2e)	**51,420,690**
Total Crediting years	**45**
Avg. ER	**1,142,682**

3. Safeguards

3.1 Statutory requirements

The project proponent, Alberami, asserts compliance with these EU and national regulations, ensuring the project aligns with both EU-wide and Italian-specific environmental, labor, and safety standards. The initiative prioritizes sustainability, adhering to stringent legislative frameworks to promote environmental integrity and social responsibility.

EU Compliance Level:

(a) EU LULUCF Regulation (2018/841): This regulation integrates greenhouse gas emissions and removals from land use, land use change, and forestry (LULUCF) into the EU's 2030 climate and energy framework. It mandates Member States to account for emissions and removals from LULUCF, aiming to enhance sustainability and climate-friendly land management, thus supporting the EU's commitment under the Paris Agreement towards emission mitigation by 2030 Appendix 3.1.

(b) EU Climate Law (2021/1119): Enacted on 29 July 2021, this law establishes a binding objective for the EU to achieve net-zero greenhouse gas emissions by 2050 and sets an interim target of at least 55% reduction of net emissions by 2030 compared to 1990 levels. It emphasizes the crucial role of both emission reductions and removal enhancements, aligning with the ambitious goals for LULUCF under the European Green Deal Appendix 3.2.

(c) EU Nature Directives: Encompassing the Habitats Directive (92/43/EEC) and the Birds Directive (79/409/EEC), these directives are pivotal in EU biodiversity conservation, promoting the maintenance of biodiversity while considering socio-economic factors. They establish the Natura 2000 network, safeguarding valuable natural habitats and species across the EU from adverse impacts Appendix 3.3.

(d) EU Forest Strategy for 2030: As part of the European Green Deal, this strategy aims to improve the quantity, quality, and resilience of EU forests. It advocates for increased carbon sequestration and aligns with the biodiversity strategy for 2030, emphasizing the protection, restoration, and sustainable management of forests to meet EU climate neutrality and biodiversity objectives, including the ambitious target of planting at least three billion trees by 2030 Appendix 3.4.

National Compliance Level (Italy):

(a) Occupational Health and Safety Act (D.Lgs. 81/2008): This act ensures the safety and health of workers, outlining the obligations of employers and the rights of employees in the workplace, promoting a safe and healthy working environment. Appendix 3.5.

(b) Fair Labor Standards Act (D.Lgs. 66/2003): This legislation governs labor standards in Italy, including work hours, rest periods, and other conditions of employment, ensuring fair treatment and adequate rest for workers. Appendix 3.6.

(c) Civil Rights Act of 1964 (Legge n. 903/1977): Although inspired by the US model, this Italian law addresses anti-discrimination in employment, ensuring equal treatment and opportunities for all employees regardless of gender, race, or other protected characteristics. Appendix 3.7 and 3.8.

(d) Italian Law on Disability Discrimination (D.Lgs. 205/2000): This law provides protections against discrimination for individuals with disabilities, ensuring access to employment, public services, and accommodations. Appendix 3.9 and 3.10.

(e) Environmental Impact Assessment (D.Lgs. 152/2006): This regulation mandates the assessment of environmental impacts for certain infrastructure projects before their approval, ensuring that potential environmental consequences are considered and mitigated. However, since AgroEcology_Italy does not fall under the category of infrastructure projects, an Environmental Impact Assessment (EIA) is not required. For reference, see Appendix 3.11.
(f) Water Pollution Control Act (D.Lgs. 152/2006): This act includes provisions for managing water quality, focusing on preventing pollution and promoting sustainable water use practices to protect aquatic environments and public health. Appendix 3.12.

(g) Land Use Planning Act (D.Lgs. 42/2004): This legislation governs land use and planning, ensuring that development is sustainable, respects environmental considerations, and aligns with regional and national planning objectives. Appendix 3.13.

(h) Food Security Act (D.Lgs. 193/2007): This act outlines requirements for agricultural practices, especially concerning the management of highly erodible lands or wetlands, aiming to ensure food safety and security while protecting the environment. Appendix 3.14.

3.2 Negative environmental and socio-economic impacts

The project under consideration is anticipated to predominantly exert beneficial environmental effects, contributing to a reduction/removal of greenhouse gas emissions. Additionally, it aims to mitigate soil erosion, decrease nutrient leaching into aquatic systems, and bolster resilience against climatic anomalies. From a socio-economic perspective, the initiative is projected to engender positive outcomes at the communal level, potentially fostering economic growth through the adoption of sustainable agricultural methodologies. Transitioning to sustainable or certified organic farming practices could elevate the market value of agricultural products, with organic produce typically securing a premium of 35-50% over conventional counterparts in the Italian market.

Despite the overarching positive outlook, there exists a possibility of initial financial hurdles for farmers due to the preliminary expenses associated with the adoption of novel agricultural practices and the potential for variations in crop yield. Nevertheless, these economic considerations are anticipated to be transient and minor in scope.

To alleviate these potential challenges, Alberami has instituted several mitigative strategies, including the provision of agronomic assistance and educational programs aimed at ensuring the newly adopted practices yield neutral or advantageous outcomes on the operational efficacy and productivity of farming activities.

Further, the provision of financial assistance manifested through initial payments and revenues derived from carbon credits, is designed to counterbalance any emergent costs or fluctuations in income. Over the long-term horizon, it is anticipated that the participating farmers will reap financial gains attributed to enhanced crop yields, particularly under conditions of extreme weather, a direct result of improved soil vitality and overall agricultural resilience. The improvement in yield quality is expected to be a significant factor contributing to these long-term benefits.

The anticipated economic and environmental advantages underscore the project's alignment with sustainable development goals, aiming to create a harmonious balance between ecological integrity and economic viability. These initiatives are reflective of broader trends in agricultural sustainability, emphasizing the importance of ecological health, economic profitability, and social and economic equity.

3.3 Consultation with interested parties and communications

The initial kick-off stakeholders meeting for the project activity was conducted in Oliveti d'Italia – Andria in the Puglia region of Italy on 21st February 2022 (Figure 9). In the meeting, the basic information of the project activity was provided to the participants and interested farmers/growers. They were given a presentation on best agricultural practices that can reduce greenhouse gas emissions. Similar meetings were conducted in the following locations and dates. See Appendix 4 Report of Stakeholder Consultation Events for the Agroecology Project for more details.

(a) Grumo Appula, Puglia region on 19 July 2022
(b) Confagricoltura Offices, Bari on 6 February 2023 (Figure 10)
(c) Campobello di Mazara, Sicily on 29 March 2023 (Figure 11)

In addition, the Project Proponent has conducted site visits and field-level demonstrations to the interested farmers/growers. The first such demonstration and site visit was conducted in Torano Castello in the Calabria region on 2 May 2023.

The consultation meetings are aimed not just at presenting and discussing the project but also at fostering relationships with local associations and cooperatives, a key aspect for the expansion of the project in the area. Such meetings are key aspects for the long-term success of the project activity. Therefore, the Project Proponent will keep on conducting these meetings in the future as well for initial project iKnstances as well as for future instances to be added. For more information about Ongoing consultation see item 3.3.1 .

Figure 9 - First Regional Stakeholder Consultation in Sicily: Held on 29 March 2023 at Campobello di Mazara, Sicily, engaging 95 participants from various sectors to discuss sustainable agriculture and carbon farming practices.

Figure 10 - First Meeting held in Bari, Puglia, held c/o the offices of Confagricoltura on 6th February 2023. Around 200 attendees representing farmers, local administration and Confagricoltura representatives.

Figure 11 – Meeting held in Campobello di Mazara (TP) Sicily, held c/o a local venue on 29th March 2023. Around 95 attendees representing farmers, local administration and agronomists.

3.3.1 Stakeholders and consultation

Stakeholder	Diverse group of stakeholders including farmers, cooperatives, millers, and businesses in the olive oil industry. See appendix 4 Stakeholders consultation report and Appendix 2 report of SDG impacts during the monitoring period.
Legal rights	Farmers in the targeted region have various rights, including representation and advocacy by professional organizations such as Confagricoltura Puglia, which defends the interests of agricultural companies; the right to information and consultation on issues affecting the sector, especially in agroecological practices and carbon farming; involvement in collaborative initiatives and access to cooperative platforms to promote dialogues and joint actions; eligibility for financial benefits or subsidies that foster sustainable practices and contribute to carbon reduction; the encouragement to adopt sustainable agricultural practices that benefit the environment and promote better land quality and production; and the right to improved quality of life and safety, through the adoption of agroecological practices that can lead to a healthier life and food security.

Diversity	A diverse group of stakeholders including farmers, cooperatives, millers, and businesses. Economics: Involved in the olive oil industry. Cultural: Deep-rooted in olive cultivation tradition.
Location	Location: C/O Oliveti d'Italia – Andria, (Puglia) This consultation took place in Andria, within the Puglia region, hosted by Oliveti d'Italia. The setting suggests a focus on olive production, which is significant in this area. Location: Grumo Appula – BA (Puglia) Another meeting in the Puglia region, this time in Grumo Appula. The specific focus or agenda of this consultation is not detailed, but given the region, it could again be related to agricultural practices or local environmental concerns. Location: Torano Castello – CS (Calabria) Moving to the Calabria region, a consultation was held in Torano Castello. This indicates an expansion of the stakeholder engagement to a different Italian region, possibly addressing regional specificities in agriculture or environmental issues. Location: Campobello di Mazara (TP) - Sicily In Sicily, the consultation was at Campobello di Mazara, indicating a further geographical spread and possibly discussing issues relevant to Sicilian stakeholders, which could range from agriculture, fisheries, to rural development. Location: Confagricoltura Offices – Bari, Puglia Returning to Puglia, a consultation was held at the Confagricoltura Offices in Bari. This location is particularly significant as Confagricoltura is a major agricultural organization in Italy, suggesting that this meeting could have a strong emphasis on agricultural policies, challenges, and developments.
Effects	Potential for an additional revenue stream through the integration of agroecological practices with carbon farming and enhanced agrarian economy through the integration of innovative cultivation techniques with existing agricultural practices.
Date of consultation	Initial Kick-off Meeting – Puglia Date: 21st February 2022 Location: C/O Oliveti d'Italia – Andria, Puglia Second Regional Stakeholder Consultation in Puglia Date: 19th July 2022 Location: Grumo Appula – BA, Puglia Third Regional Stakeholder Consultation in Puglia

	Date: 6th February 2023 Location: Confagricoltura Offices – Bari, Puglia First Regional Stakeholder Consultation in Sicily Date: 29th March 2023 Location: Campobello di Mazara (TP) - Sicily First Regional Stakeholder Consultation in Calabria, Field Visits and Demonstrations Date: 2nd May 2023 Location: Torano Castello – CS, Calabria
Stakeholder engagement	Meeting at Oliveti d'Italia offices, Andria; PowerPoint presentation, discussions on agroecological practices, Q&A session.
Consultation	Discussion focused on the integration of agroecological practices with carbon farming within olive groves, aiming to generate additional revenue for farmers. Aimed at investigating the potential integration of agroecological methods and carbon farming into local agricultural practices, fostering relationships with local associations and cooperatives.
Stakeholder input	Input was gathered through discussions and a Q&A session, leading to collaborative strategies and a cooperative dialogue on innovative farming techniques. Discussion and Q&A session engaged stakeholders in practical examination of project implementation, fostering discourse on sustainable agriculture.
Free prior informed consent	Farmers interested in joining the ALBERAMI program are required to enter into a contractual agreement with the Project Proponent. This agreement mandates the implementation of at least three new agronomic practices that align with the best agricultural practices (BAPs) outlined by the project. To ensure the additionality of the carbon reductions achieved, the farmers must not have used these sustainable practices prior to joining the program. As of September 2023, the project has engaged a substantial number of farmers, with over 296 registered on the Alberami platform. This wide engagement indicates a successful outreach and consent process, ensuring that stakeholders are both informed and willing to participate.
Conclusion	Positive reception: stakeholders showed significant interest and engagement, establishing a cooperative dialogue for future initiatives.
Ongoing consultation	The ongoing process of consultation with stakeholders for the Agroecology Project incorporates several interactive and accessible methods: **Online Questionnaires:** Utilized to gather a wide range of feedback and insights from stakeholders, allowing for broad participation. **Telephone Hotline:** Offers immediate and direct communication for stakeholders to express concerns or ask questions. **+44 351 821 4474**

	Digital Platforms: Information sharing and engagement through the project's website and Instagram account to reach a diverse audience. Facebook: https://www.facebook.com/Alberami.it LinkedIn:https://it.linkedin.com/company/alberami Instagram: https://www.instagram.com/alberami_it Website: www.alberami.com **Online and face-to-face Meetings:** Facilitates real-time discussions and updates, enabling stakeholders from different locations to participate without travel constraints.

3.3.2 Public comments

Comments received	Action taken
No public comments yet	

3.4 Environmental impact assessment

This initiative is not expected to have negative environmental impacts.

3.5 Risk assessment

	Risks identified	Mitigation measures
Risk 1	**The environmental risk:** The Mediterranean Basin faces several critical challenges, including diminishing water resources, soil erosion, rampant forest fires, soil degradation, desertification, and declining agricultural and ecosystem productivity. Furthermore, the region contends with the exacerbating effects of ongoing climate change, which serve as potential catalysts for highly adverse outcomes in the coming decades. According to the Risk Analysis. Climate Change in Italy, a document elaborated by the The Euro-Mediterranean Center on Climate Change CMCC Foundation in 2020, In Italy, climate change is manifesting through rising temperatures, altered rainfall patterns, and an increase in extreme weather events. The most severe scenario, RCP8.5, projects a troubling +5°C rise in average temperatures by 2100 compared to the turn of the century. This will be accompanied by a significant reduction in annual precipitation levels and a heightened intensity of rainfall on wet days. Furthermore, Italy can expect more frequent hot and dry days throughout the year, exacerbating the challenges posed by climate change. Notably, Italy's marine environment will also undergo substantial changes, including rising surface temperatures and sea levels. These transformations will have detrimental effects on the provision of vital "ecosystem goods and services" along the coastlines, with implications for the socio-economic system as a whole. To mitigate these impacts and adapt to a changing climate, Italy	Please refer to section 8.3

must prioritize sustainable strategies and proactive measures in its environmental and economic planning.

According to the report, In the coming decades, Italy can anticipate relatively stable annual precipitation patterns, with discernible variations observed on a seasonal scale, such as decreased summer rainfall in central-southern regions and increased winter precipitation in the north.

In a low emissions scenario, the projected temperature fluctuations are expected to stay relatively moderate, with an increase of approximately +1.5°C by both 2050 and 2100. Conversely, in a high emissions scenario where greenhouse gas (GHG) emissions remain unchecked, significantly more substantial temperature deviations are anticipated for both 2050 and 2100.

The following graph (Figure 14) demonstrates the forecast of different scenarios for mean temperature evolution in the next 80 years.

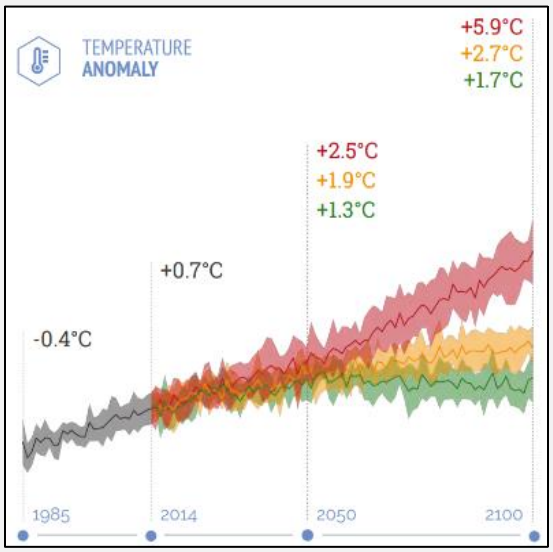

Figure 14: The forecast of different scenarios for mean temperature evolution in the next 80 years. (Source: CMC, 2020)

Risk 2	*Geo-hydrological Perils:* Italy is profoundly susceptible to geological, hydrological, and hydraulic instabilities, posing a substantial hazard to its population. The escalating temperatures and the heightened occurrence of localized precipitation events significantly contribute to the exacerbation of these geo-hydrological risks across the region. Furthermore, human activities, including land consumption, urban sprawl, and occupation of riverine zones, coupled with rising temperatures and an uptick in localized precipitation events, play a pivotal role in amplifying these perilous challenges. With the anticipated rise in temperatures, the consequences of melting snow, ice, and permafrost will become more severe, particularly impacting the Alpine and Apennine regions in terms of the magnitude and seasonal timing of disruptive events. Additionally, the expected increase in intense precipitation patterns heightens hydraulic risks for smaller basins, which tend to overflow during heavy rains before larger basins and raises the vulnerability to surface landslides in areas with more porous soils. Overall, Italy's climate change impacts are set to intensify the challenges posed by geo-hydrological instability, compounding an already complex situation. Consequently, addressing climate risks in Italy necessitates a comprehensive strategy that combines mitigation, such as reducing river flow to the ridge and redesigning defense structures for various disruptions in the hydrological and geological domains, with adaptation measures aimed at enhancing resilience within the social system.	Refer to section 8.3
Risk 3	*Water resources:* The analysis, conducted at the district and river basin levels, reveals that climate change is leading to a reduction in both the quantity and quality of water resources. Over the coming decades, factors like rising average temperatures, increased evapotranspiration, and decreased rainfall are expected to significantly diminish water flow, with a projected 40% reduction by 2080. Anthropogenic activities, particularly increased water withdrawals, are further anticipated to cause a 10-15% decline in flow rates. This intensifies the competition for water resources among sectors, including civil use, tourism, industry, power generation, and agriculture, emphasizing the growing importance of maintaining a delicate balance between water demand and availability. These conflicts are most pronounced during the summer months when demand peaks but water resources are scarcer. Outdated and inadequate infrastructure underscores the pressing need for enhanced water resource management to ensure not only human needs but also the allocation of sufficient water flow to ecosystems. Extended dry periods, which are projected to increase in Italy based on climate change scenarios, are expected to have detrimental effects on water quality, leading to reductions in flow rates and inflow velocities. These phenomena contribute to eutrophication, characterized by an upsurge in aquatic plant biomass that degrades the overall quality of water resources. Moreover, prolonged droughts and reduced flow rates, coupled with water resource over-exploitation, heighten the vulnerability of watercourses and coastal groundwater reserves, particularly in lowland areas, to rising sea levels. This can result in saltwater intrusion and increased salinity in freshwater reserves. Lastly, the anticipated increase in heavy rainfall in Italy is likely to lead to sudden floods and runoff events, which, in turn, elevate the input of nutrients and contaminants from agriculture and livestock farming into the water systems.	Refer to section 8.3
Risk 4	*Agriculture impacts expected:* Italy holds a prominent position as a significant agricultural producer and exporter, with agriculture remaining a crucial sector in terms of both GDP contribution and employment generation. The Italian agricultural landscape exhibits remarkable diversity, ranging from highly intensive farming practices in the northern regions to extremely marginal and fragmented farms in mountainous and southern areas. Arable crops cover more than half of the total agricultural	

area (54.5%), with the remaining land comprising grasslands and pastures (26.7%) and agricultural woody crops (18.5%). Maize and wheat cultivation alone contribute to approximately 80% of the total cereal production, while notable tree crops include olive and grape cultivation.
Irrigation plays a pivotal role, accounting for around 50% of total water usage in agriculture. It is predominantly employed for crops such as maize, vegetables, fodder crops, and various tree crops like olives, grapes, and citrus, underscoring its significance in sustaining Italian agriculture.
For crops, the projected rise in average temperatures is expected to bring about alterations in the duration of the growing season, earlier onset of phenological phases, and the possibility of shifting cultivation areas towards higher latitudes and altitudes, where more favorable conditions for growth and development may prevail. However, Italy may face reduced productivity, particularly for spring-summer crops, especially those that rely on non-irrigated methods. There's also the potential for a northward shift in arable land use, particularly for crops like olive trees and grapevines, although this expansion might be curtailed by the anticipated increase in extreme weather events. The livestock sector is not immune to the impact, as elevated temperatures lead to prolonged heat stress, which in turn affects animal welfare and product quality, ultimately impacting the sector's overall productivity.
the primary anticipated effects on crop and animal production by employing two approaches: an examination of existing literature and model simulations that gauge yield fluctuations in cereal crops. This comprehensive analysis also accounts for uncertainties associated with climate projections and explores how the direct impact of rising atmospheric CO2 concentrations may mitigate adverse climate change effects on crops. Additionally, for the livestock sector, the report examines expected projections for the Temperature Humidity Index (THI), a composite measure that reflects the combined influence of temperature and humidity. This evaluation helps assess potential implications for animal welfare and well-being.
In the forthcoming decades, it is anticipated that certain regions may experience a substantial decline in irrigated corn yields, ranging from 25% to 50% compared to current levels, as indicated by the examined scenarios. Yield reductions are also expected for wheat, particularly in southern Italy and the Italian islands, while certain areas in central and northern Italy may witness yield increases. Elevated atmospheric CO2 concentrations have the potential to enhance photosynthetic activity and crop water utilization efficiency. However, this could have adverse consequences on product nutritional quality, leading to decreased protein content in cereals, impaired wheat baking quality, and diminished concentrations of essential nutrients such as iron and zinc, thereby impacting nutritional aspects. It is imperative to conduct further research to comprehensively investigate the impact of increased atmospheric CO2 concentrations on crop productivity and food quality.
the assessment of climate risk in irrigated agriculture due to climate change is intricately linked to the unique crop requirements and prevailing climatic conditions in each region. It necessitates a meticulous evaluation of the susceptibility and adaptability of water supply systems to accommodate the growing demand for crop irrigation. Anticipated adverse climate change effects on livestock are multifaceted, encompassing aspects related to the health, production, and reproduction of various species. Dairy cattle and pigs are deemed particularly vulnerable, while poultry exhibits a medium level of vulnerability, and beef cattle range from low to medium vulnerability.
The water demand for irrigation is expected to increase in a wide range of Italian territory, that could variate between 17 to 20% of the volume amount required and its impact is expected in almost all the regions as demonstrated through the following map presented by CMCC foundation (Figure 15).

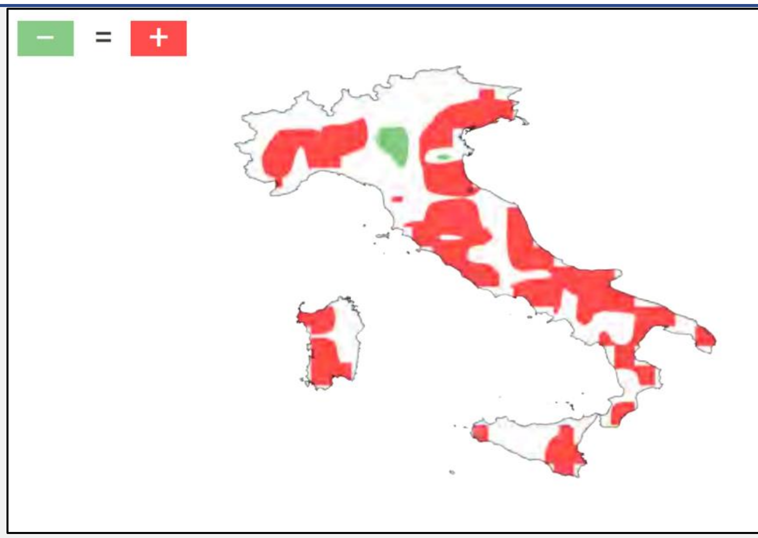

Figure 15: The water demand for irrigation in Italy.

The findings from this analysis underscore a heightened risk scenario for southern Italy, where lower water availability is expected to result in elevated irrigation costs. This scenario is likely to intensify competition among sectors for access to water resources, jeopardizing productive processes, particularly in downstream areas of the primary water basins (Figure 16).

The quantitative productivity impact was also evaluated in a study coordinated by the department of civil and environmental engineering of University of Perugia[1] which concludes that even in the more optimistic scenario some productive reduction is expected in general, although some regions could face a slight increase that do not compensate the most intense lost in the majority part of the Italian olive production.

[1]Orlandi, F; Rojo, Jesús; Picornell,A; Oteros, J; Pérez-Badia, R; Fornaciari, M. Impact of Climate Change on Olive Crop Production in Italy. Aviable at < https://www.mdpi.com/734596 >

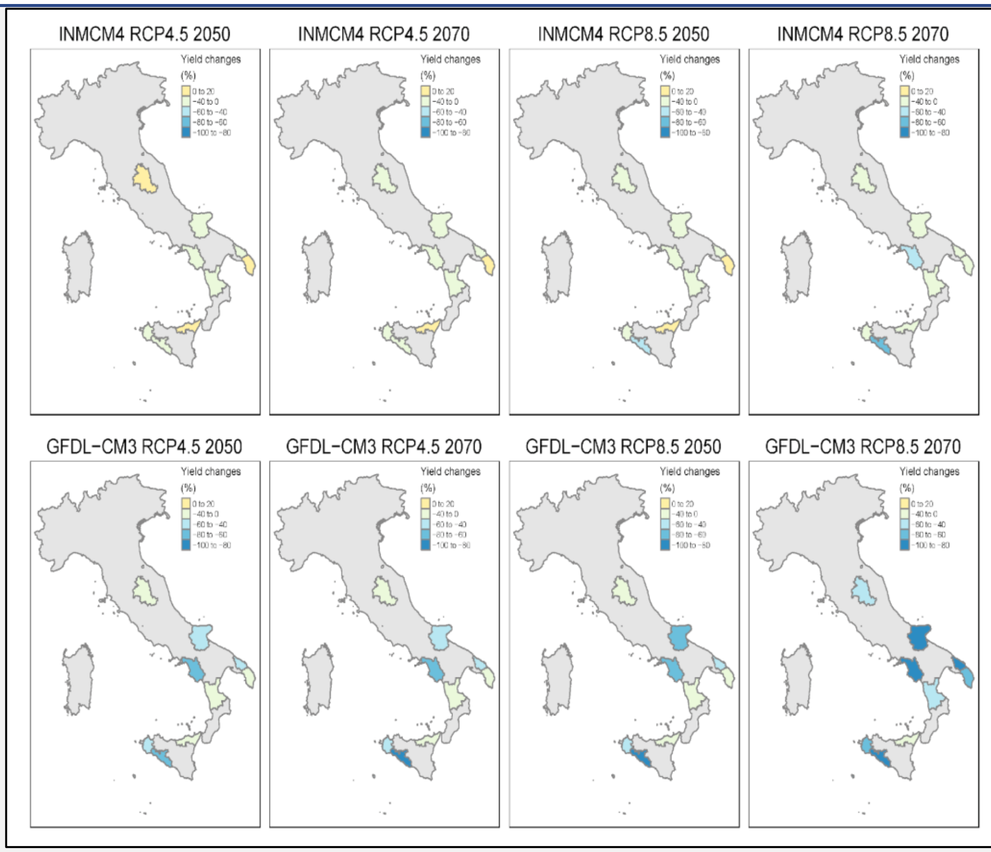

Figure 16: Future climate change scenarios.

The results from climate models indicate that by 2050, there is an average projected reduction in olive production of approximately 26.6% to 34.1%, depending on the climate scenario considered (RCPs 4.5 and 8.5). However, some Italian provinces, such as Perugia, Lecce, and Messina, may experience a modest increase in production, typically below 20% compared to current production. As the time horizon extends to 2070, the projections suggest an even more pronounced decrease in olive production, with some areas facing reductions exceeding 40%. These negative impacts on olive production are primarily attributed to rising temperatures and arid conditions during the summer, posing a significant challenge to traditional olive farming in the region.

Forest fires

Described in section 8.3

In Italy, all climate scenarios project a significant fire risk increase exceeding 20%, along with an expected extension of the fire season by 20 to 40 days in the upcoming decades. These changes are anticipated to result in an increase in burned areas ranging from 21% to 43%, contingent upon the scenario under consideration. The expansion of burned regions will consequently lead to heightened emissions of vegetation fires, including CO2 and particulate matter, adversely impacting local air quality and human health. Furthermore, this situation may exert a substantial influence on the atmospheric budget and regional as well as global carbon cycles.

Technical risks. The listed technical risks associated with each one of practices, are related with eventual and temporary decrease of productivity due to the transitory process of learning and adaptation to new practices which replace, at least in part, the traditional knowledge usually applied by decades.

3.5.1 Additional information on risk management

No addition information at this moment.

4. Methodology

4.1 Reference to the applied Methodology (if applicable)

The project's methodological framework is built upon the integration of the C-Farms, Verra's VM0042 Version 1.0, and the CDM's AR-AMS0007 Version 3.1. These methodologies collectively serve as the foundational pillars for the project's design and implementation.

4.2 Deviation from methodology

No deviation applied

4.3 Other information relating to methodology application

In our project design document, it is important to state that the methodologies C-Farms, Verra's VM0042, and the CDM's AR-AMS0007 are not criteria for validation or verification. Instead, these methodologies serve as supporting tools to demonstrate conformity to the established criteria.

5. Monitoring

5.1 Monitoring plan

A) purpose of monitoring:

The primary purpose of monitoring the AgroEcology_Italy project is to evaluate and ensure the effective transformation of Italian agriculture towards more sustainable practices through the implementation of agroecology and agroforestry methods. For the initial batch of Project instances which encompasses 67 farms distributed over 1474.89 hectares only agroecology best practices were implemented. The monitoring activities aimed to:

1. Assess Environmental Impact: To systematically measure the project's success in reducing greenhouse gas emissions and enhancing carbon sequestration, contributing to Italy's environmental sustainability goals.

2. Validate Methodological Approaches: To verify that the methodologies adopted from Verra's VM0042 coupled with the RothC model for assessing soil carbon dynamics, are correctly applied and effective in the context of Italian agricultural landscapes.

3. Ensure Scientific Rigor: To underpin all project activities with robust scientific evidence, leveraging peer-reviewed studies, extensive databases, and original data collection, thereby ensuring that the project's outcomes are reliable and credible.

4. Track Progress and Performance: To monitor the progress of implementing agroecology and agroforestry practices across the 67 farms spanning 1474.89 hectares, ensuring that the project is on track to meet its objectives and identifying any areas needing adjustment.

5. Facilitate Continuous Improvement: To use the data and insights gained from monitoring to refine and improve the project's strategies and interventions, ensuring that the practices are adapted to local conditions and are as effective as possible in enhancing sustainable agricultural practices.

Monitoring the AgroEcology_Italy project is crucial for ensuring that the transition towards sustainable agricultural practices is not only envisioned but also effectively achieved, leading to measurable environmental, economic, and social benefits.

B) list of parameters being measured and monitored:

1. Climate Data: This includes measurements of Temperature, Precipitation, and Evapotranspiration, utilizing data derived from MODIS imagery to assess climatic conditions.
2. Soil Carbon Stock (SOC): This is quantified in tons of CO2 per hectare (tCO2 ha-1), indicating the amount of carbon stored within the soil.
3. Soil Organic Matter (SOM): Evaluated as a percentage, indicating the proportion of organic material present in the soil.
4. Phosphorus: Measured in parts per million (ppm), indicating the concentration of this essential nutrient.
5. Bulk Density: Measured in grams per cubic centimeter (g/cm^3), reflecting the compactness of the soil.
6. Total Nitrogen: Quantified in milligrams per kilogram (mg/kg), representing the nitrogen content of the soil.
7. Organic Carbon: Measured in milligrams per kilogram (mg/kg), indicating the level of organic carbon present.
8. Soil Texture Components: Analyzed in terms of percentage composition of sand, silt, and clay.
9. Soil Depth: Measured in centimeters (cm).

C) Types of data and information to be reported, including units of measurement:

Field data collected and subsequently analyzed in the laboratory, alongside the development and updating of a geographical database with data from official sources or scientific databases. The following parameters were collected in the field and later measured in specialized laboratories—*Eco Control sasLaboratorio Analisi Chimiche-Batteriologiche-Ambientali -Studio Tecnico Chimico Ambientale and Labsel s.r.l. Laboratorio di analisi chimico-fisiche e microbiologiche ambientali* (Appendix 5 Tabulated result of soil samples taken in the field and measured in the laboratory):

i) Soil Organic Matter (SOM) (%)
ii) Phosphorus (ppm)
iii) Bulk Density (g/cm^3)
iv) Total Nitrogen (mg/kg)

v) Organic Carbon (mg/kg)
Based on these data, the Soil Carbon Stock (SOC) (tCO2 ha-1) was calculated as detailed in Appendix 5.

D) origin of the data;

Climate data including:

- Temperature (ºC) (Appendix 6)
- Precipitation (mm) (Appendix 7)
- Evapotranspiration (mm) (Appendix 8)

Those were all derived from MODIS imagery.

- Practices applied in terms of area and carbon inputs (Appendix 9) were obtained through questionnaires and surveys (Appendix 1).

- Soil Texture Components, Soil Depth, and Soil Carbon Stock (SOC) (tCO2 ha-1) for the baselines (Appendix 10)

- Practices applied in terms of time since the beginning of the project (Appendix 11) were obtained through questionnaires and surveys (Appendix 1).

List of data sources:
- Soil Map Vector Database at 1:1,000,000 Scale: Available on Zenodo, this database provides comprehensive information on soil typological units and extensive soil regions across Italy, essential for understanding the soil characteristics of the project areas. (Costantini, E.A.C., L'Abate, G., Barbetti, R., Fantappiè, M., Lorenzetti, R., & Magini, S. (2022). The soil province geodatabase of Italy. Zenodo. https://zenodo.org/record/7072306)
- 500-meter Grid of Derived Soil Profiles for Italy (SuoliCella500): Also on Zenodo, this resource offers detailed views of soil profiles across Italy, derived from neural network analyses of observed soil profiles, assisting in the accurate implementation of regenerative practices. (L'Abate, G., Barbetti, R., Costantini, E.A.C., et al. (2022). 500-meter grid of Derived Soil Profiles (DSP) for Italy - SuoliCella500. Zenodo. https://zenodo.org/record/7105023)
- Topsoil SOC and Salt-Affected Soil Databases: These databases provide targeted data on soil organic carbon levels and the presence of salt-affected soils, respectively, guiding strategies for improving carbon sequestration and addressing soil health challenges. (Maria Fantappiè et al. (2018). Elaboration of the Italian portion of the global soil organic carbon map (GSOCMAP) (1.2.0) [Data set]. Eurosoil 2020, Connecting people and soil, Geneva, Switzerland. Zenodo. https://doi.org/10.5281/zenodo.7746495)

monitoring methodologies, including estimation, modeling, measurement, calculation approaches, and uncertainty.

E) monitoring methodologies, including estimation, modeling, measurement, calculation approaches, and uncertainty;

The prediction and validation of SOC for the AgroEcology_Italy project was conducted using the RothC model and involved several steps to ensure accuracy and relevance to the project's specific context. This process starts with organizing and analyzing extensive climatic data retrieved from MODIS images, covering temperature, precipitation, and evapotranspiration rates over a decade. This climatic dataset, after being meticulously organized and filtered for relevant properties, serves as a foundational element for running the RothC model simulations.

The project undertakes a detailed approach to calibrating the model, incorporating experimental data selection and adjustments specific to Italy's agricultural context. This involves using R scripts to process and prepare the data, ensuring that variables like soil carbon stocks, carbon input over time, and environmental effects on decomposition rates are accurately captured and reflected in the model's simulations. The RothC model simulations are then conducted, considering the unique characteristics of each of the 67 farms under the project, spanning an area of 1474.89 hectares. This process not only validates the model against the specific conditions and practices of the AgroEcology_Italy project but also predicts the impact of regenerative agricultural activities on soil carbon dynamics over time.

f) Monitoring Frequency:

The monitoring frequency is designed to align with the seasonal cycles and critical agricultural activities to provide a comprehensive view of the soil carbon dynamics throughout the year. For the AgroEcology_Italy project, soil parameters, climate data, and agricultural practices are monitored on an annually between the months of May/June. This frequency allows for capturing significant changes due to seasonal variations while balancing the logistical demands of data collection and analysis.

g) Monitoring Roles and Responsibilities:

The project establishes clear roles and responsibilities to ensure the integrity and accuracy of the monitoring process see Figure 3 organogram of the Monitoring, Reporting and Verification (MRV) of the Project Activity.

MRV Manager: Oversees the entire monitoring operation, ensures compliance with project goals, and coordinates between different teams.
Soil Scientist & Sampling: Responsible for the systematic collection of field data and climate parameters, adhering to predefined protocols to ensure data quality.
Laboratory Analysts: Conduct detailed analyses of soil samples to determine organic carbon levels, bulk density, and other crucial parameters.
Data Analyst and GIS /Remote Sensing Analyst: Handle the processing and interpretation of collected data, utilizing the RothC model and SoilR package for SOC dynamics simulation.
Quality Assurance (MRV Manager): Ensures the reliability and accuracy of data collection, analysis, and reporting processes, and addresses any discrepancies or issues.
Documentation (MRV Manager): Maintains comprehensive records of all data, methodologies, and findings, ensuring that changes to recorded data are authorized, approved, and properly documented.

h) Controls and Corrective Actions:

The project implements robust controls across all stages of data handling:
Internal Data Checks: Automated and manual checks are applied to data input, transformation, and output phases to identify and correct errors. These checks include range validations, consistency checks across data sets, and verification of data formatting and completeness.
Data Transformation and Analysis: Procedures are established to ensure that data transformations maintain data integrity. This includes maintaining audit trails for all data manipulations, ensuring transparency, and enabling traceability.
Output Validation: Outputs from the RothC model simulations are systematically validated against independent datasets, historical trends, and field observations to ensure their accuracy and realism.
Corrective Actions: A clear procedure is in place for addressing any data discrepancies or anomalies identified during internal checks or external validations. This involves re-evaluating the data in question, correcting any errors found, and documenting the issue and resolution process comprehensively.
Regular Training and Reviews: Continuous training for team members on data handling, monitoring protocols, and use of the RothC model ensures that all personnel are up to date with the best practices and project requirements.
Regular review meetings are held to discuss the monitoring process, findings, and improvements, fostering a culture of continuous improvement.

5.2 Data and parameters remaining constant

For the initial instances of the project, not all constant parameters outlined in the PDD were used in this MRV. This is because it involves only 67 farms with a limited variation in applied practices.

Data / Parameter	AR
Data unit	Percent
Description	Weighted average adoption rate.
Source of data	Calculated for the project across the group or all activity instances.
Value applied	Must be less than or equal to 20%
Justification of choice of data or description of measurement methods and procedures applied.	See section 7 of VM0042.
Purpose of Data	Common practice assessment.
Comments	This information was be taken through surveys and platform developed by ALBERAMI

Data / Parameter	Areaan
Data unit	Ha
Description	Area of proposed project-level adoption of each activity
Source of data	Farm records and project activity commitments
Value applied	The proposed project-level adoption of Activityan

Justification of choice of data or description of measurement methods and procedures applied.	See section 7 of VM0042.
Purpose of Data	Common practice assessment
Comments	This information will be taken through surveys and platform developed by ALBERAMI

Data / Parameter	EAan
Data unit	Percentage
Description	Adoption rate of the n largest most common proposed project activity in the region
Source of data	Publicly available information contained in agricultural census or other government (e.g., survey) data, peer-reviewed scientific literature, independent research data, or reports/assessments compiled by industry associations. If all of the above sources are unavailable, signed and date attestation statement from a qualified independent local expert.
Value applied	Conditional on data source.
Justification of choice of data or description of measurement methods and procedures applied.	See source of data above and Section 7 of VM0042.
Purpose of Data	Common practice assessment.
Comments	This information will be taken through surveys and platform developed by ALBERAMI

Data / Parameter	A0
Data unit	Unit area

Description	Project area
Source of data	Measured in project area
Value applied	The project area will be measured prior to validation. In the present project instance, it is 1474.89 ha.
Justification of choice of data or description of measurement methods and procedures applied.	Delineation of the project area may use a combination of GIS coverages, ground survey data, remote imagery (satellite or aerial photographs), or other appropriate data. Any imagery or GIS datasets used must be geo-registered referencing corner points, clear landmarks, or other intersection points.
Purpose of Data	Calculation of baseline and project emissions
Comments	This variable is measured when farmers provide the slots of farms and is then digitalized in shapefiles by GIS Analysts

Data / Parameter	The Italian Portion of The Global Soil Organic Carbon Map (GSOCMAP)
Unit	tCha-1
Description	The Global Soil Organic Carbon map for Italy estimates soil organic carbon stock (CS) at 0-30 cm depth, using data from 1990-2013. With 6748 sampled points, corrected SOC values and estimated bulk density, the map employs interpolation methods like neural networks and GLM, validated with MAE and RMSE statistics. Contact for data inquiries is available through the Research Centre for Agriculture and Environment (CREA).
Origin of data	CREA (Consiglio per la Ricerca in Agricoltura e l'analisi dell'Economia Agraria) - Italy
Value applied	NA
Justification of choice of data or description of measurement methods and procedures applied	The choice of data source for the Italian portion of the Global Soil Organic Carbon Map (GSOCmap) was justified based on its Research Centre for Agriculture and Environment (CREA), which is are significant soil data owner in Italy. The dataset, comprising 6748-point samples collected between 1990-2013, utilized soil organic carbon (SOC) values obtained through rigorous methods such as the Springer and Klee and flash combustion elemental analyzer methods, with correction applied to Walkey and Black method values. Bulk density (BD) measurements were conducted using undisturbed sampling, the core method, and the pit method. Mapping was achieved through Neural Networks and Generalized Linear Models (GLM), with validation statistics including Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE) indicating robustness. The responsible entity for data maintenance and inquiries is the Research Centre for Agriculture and Environment (CREA), with contact provided via edoardo.costantini@crea.gov.it.
Purpose of Monitoring	☒ Calculation of baseline emissions ☐ Calculation of project emissions

	☐ Calculation of leakage
Comments	The methodology used to model the data between 2013 and 2021 was based on the RothC model, considering that the available data referred to the period of point sample collection between 1990 and 2013. We applied the RothC model to model the data for the interval between 2013-2021 using inputs related to the land use history for the initial properties. The baseline scenario for soil organic carbon (SOC) stock was calculated as an average between 1990 and 2013 (Fantappie et al., 2018). Therefore, it was necessary to model the carbon dynamics for the period between 2014 and 2020. Environmental variables were extracted using the Google Earth Engine for this period and for the following period (2021-2023). Carbon inputs for the first period were treated as constant and corresponded to the expected input for olive tree crops (0.06 per month), based on the table of agricultural practice inputs. Subsequently, each property had its carbon inputs increased depending on the implemented practice.

Data / Parameter	500-meter grid of Derived Soil Profiles (DSP) for Italy - SuoliCella500
Unit	Sand (%) Silt (%) Clay (%) Soil Depth (cm)
Description	National database of Italian Soil Typological Units (STU) and corresponding Derived Soil Profiles (DSP) obtained on a 500 meters grid (1,109,672 points) by neural network. The most probable WRB Reference Soil Group (RSG), WRB Qualifiers, and USDA textural soil types were mapped on the 500 meters grid, by neural network. 18,707 Observed soil profiles and the respective 33,014 Soil Horizons were grouped into 4,472 STUs based on the combinations of Soil Region, WRB Reference Soil Group (RSG), WRB Qualifiers, and USDA textural soil types obtained on the 500 meters grid. Statistics were calculated (Mean Value, Standard Deviation Value, and Numerosity) for soil rooting depth and for the most common analytical parameters of the soil horizons (Coarse fragment content fraction; pH in water; Carbon (C) - organic; Carbonate (CO3--) - Total; Clay, Sand, and Silt fraction; Granulometry; Textural soil types). The 500 meters grid adopts EPSG 23032 (ED50 UTM-32). A reference scale of 1:250.000 may be attributed to the 500-meters grid map, on the base of the numerosity of DSP produced for the whole Italian territory.
Origin of data	CREA Consiglio per la ricerca in agricoltura e l'analisi dell'economia agrarian - Italy
Value applied	NA
Justification of choice of data or description of measurement methods and procedures applied	A 500-meter grid of Derived Soil Profiles (DSP) for Italy - SuoliCella500 contains data and information about soil characteristics throughout the territory of Italy. The data was selected for being official and containing information such as Sand (%), Silt (%), Clay (%), and Soil Depth (cm). The responsible entity for data maintenance and inquiries is the Research Centre for Agriculture and Environment (CREA), with contact provided via edoardo.costantini@crea.gov.it.
Purpose of Monitoring	☒ Calculation of baseline emissions

	☐ Calculation of project emissions ☐ Calculation of leakage
Comments	NA

5.3 Data and parameters monitored

Data / Parameter	**Reference evapotranspiration (ASCE Penman-Montieth)**
Unit	mm
Description	evapotranspiration (ASCE Penman-Montieth)" refers to a dataset provided by Idaho EPSCoR and TERRACLIMATE. It represents reference evapotranspiration calculated using the ASCE Penman-Montieth method. Evapotranspiration is the combined process of water evaporation from the soil surface and transpiration from plant leaves. The ASCE Penman-Montieth method is a widely used approach for estimating reference evapotranspiration, which is the amount of water that would evaporate from a well-watered grass surface under specified climatic conditions. This dataset is valuable for understanding water dynamics in various ecosystems and for applications in agriculture, hydrology, and climate research.
Origin of data	The data/parameter "IDAHO_EPSCOR/TERRACLIMATE Reference
Monitored value	Reference evapotranspiration per farm polygon
Justification of choice of data or description of measurement methods and procedures applied	Availability of monthly data for all of Europe
Monitoring frequency	monthly
Purpose of data	☒ Calculation of baseline emissions ☐ Calculation of project emissions ☐ Calculation of leakage
Quality assurance and control	NA
Comments	NA

Data / Parameter	**MODIS Temperature**
Unit	degrees Celsius
Description	The MOD11A2.061 dataset provides global coverage of land surface temperature (LST) and emissivity data derived from Terra satellite observations. With an 8-day temporal resolution and a spatial resolution of 1 kilometer, it offers valuable insights into surface energy balance, environmental changes, and ecosystem dynamics.

	Widely used in climate research, agriculture, hydrology, and environmental monitoring, this dataset aids in studying land surface processes, urban heat islands, drought conditions, and vegetation health. Overall, it serves as a crucial resource for understanding land surface dynamics and climate-related phenomena at regional and global scales.
Origin of data	MODIS/061/MOD11A2
Monitored value	MOD11A2.061 Terra Land Surface Temperature and Emissivity 8-Day Global 1km
Justification of choice of data or description of measurement methods and procedures applied	Availability of monthly data for all of Europe
Monitoring frequency	monthly
Purpose of data	☒ Calculation of baseline emissions ☐ Calculation of project emissions ☐ Calculation of leakage
Quality assurance and control	NA
Comments	NA

Data / Parameter	**CHIRPS Rainfall**
Unit	mm/pentad
Description	The CHIRPS Pentad dataset, developed by the Climate Hazards Group, combines satellite infrared data with ground station observations to provide high-resolution precipitation estimates. It operates on a pentad (5-day) temporal resolution and offers global coverage. By integrating both satellite and ground-based data, CHIRPS Pentad enhances the accuracy and reliability of precipitation monitoring, making it valuable for various applications including drought monitoring, hydrological modeling, and agricultural planning. This dataset serves as a crucial tool for assessing climate-related hazards and supporting decision-making processes in areas vulnerable to precipitation variability.
Origin of data	UCSB-CHG/CHIRPS/PENTAD
Monitored value	Provide estimation on value
Justification of choice of data or description of measurement methods and procedures applied	Availability of monthly data for all of Europe
Monitoring frequency	monthly

Purpose of data	☒ Calculation of baseline emissions ☐ Calculation of project emissions ☐ Calculation of leakage
Quality assurance and control	NA
Comments	NA

Data / Parameter	i) Soil Organic Matter (SOM) (%)
Unit	%
Description	i) Soil Organic Matter (SOM) (%): Soil Organic Matter refers to the amount of organic material present in the soil, typically expressed as a percentage of the soil's total weight. It includes decomposed plant and animal residues, microorganisms, and other organic materials. SOM plays a crucial role in soil fertility, structure, and nutrient cycling.
Origin of data	field collections
Monitored value	NA
Justification of choice of data or description of measurement methods and procedures applied	Given the critical importance of accurate soil data in agricultural and environmental management within the context of AgroEcology_Italy, the choice of data source is paramount. The selected data source should offer reliable information on soil parameters such as Soil Organic Matter (SOM), Phosphorus, Bulk Density, Total Nitrogen, and Organic Carbon. One possible data source could be a soil laboratory that adheres to established standards and protocols for soil analysis. The laboratory should follow recognized methods for measuring each parameter, ensuring consistency and reliability of the results. These methods may include but are not limited to: 1. Soil Organic Matter (SOM) (%): Measurement of SOM percentage can be carried out using methods such as the Walkley-Black method, loss on ignition (LOI), or dry combustion method. The chosen method should be validated and accredited, with uncertainty estimates provided. References to recognized standards, protocols, and previous studies validating the chosen methods can strengthen the justification for the data source. Additionally, transparency regarding the measurement procedures, calculation approaches, and associated uncertainties enhances the credibility and reliability of the soil data obtained.
Monitoring frequency	Annually
Purpose of data	☒ Calculation of baseline emissions ☐ Calculation of project emissions ☐ Calculation of leakage

Quality assurance and control	NA
Comments	NA

Data / Parameter	ii) Phosphorus (ppm)
Unit	ppm
Description	ii) Phosphorus (ppm): Phosphorus concentration in soil is measured in parts per million (ppm). Phosphorus is an essential nutrient for plant growth, primarily involved in processes like energy transfer, photosynthesis, and root development. Soil phosphorus levels influence plant productivity and are critical for agricultural management and environmental sustainability.
Origin of data	field collections
Monitored value	NA
Justification of choice of data or description of measurement methods and procedures applied	Given the critical importance of accurate soil data in agricultural and environmental management within the context of AgroEcology_Italy, the choice of data source is paramount. The selected data source should offer reliable information on soil parameters such as Soil Organic Matter (SOM), Phosphorus, Bulk Density, Total Nitrogen, and Organic Carbon. One possible data source could be a soil laboratory that adheres to established standards and protocols for soil analysis. The laboratory should follow recognized methods for measuring each parameter, ensuring consistency and reliability of the results. These methods may include but are not limited to: 2. Phosphorus (ppm): Soil phosphorus concentration can be determined through various extraction methods like Olsen, Mehlich-3, or Bray methods, followed by colorimetric analysis. The laboratory should specify the extraction and analysis techniques used, along with any quality control measures implemented. References to recognized standards, protocols, and previous studies validating the chosen methods can strengthen the justification for the data source. Additionally, transparency regarding the measurement procedures, calculation approaches, and associated uncertainties enhances the credibility and reliability of the soil data obtained.
Monitoring frequency	Annually
Purpose of data	☒ Calculation of baseline emissions ☐ Calculation of project emissions ☐ Calculation of leakage
Quality assurance and control	NA

Comments	NA

Data / Parameter	iii) Bulk Density (g/cm³)
Unit	g/cm³
Description	iii) Bulk Density (g/cm³): Bulk density represents the mass of soil per unit volume and is typically measured in grams per cubic centimeter (g/cm³). It provides insights into soil compaction, porosity, and water retention capacity. Bulk density affects root penetration, soil aeration, and overall soil health.
Origin of data	field collections
Monitored value	NA
Justification of choice of data or description of measurement methods and procedures applied	Given the critical importance of accurate soil data in agricultural and environmental management within the context of AgroEcology_Italy, the choice of data source is paramount. The selected data source should offer reliable information on soil parameters such as Soil Organic Matter (SOM), Phosphorus, Bulk Density, Total Nitrogen, and Organic Carbon. One possible data source could be a soil laboratory that adheres to established standards and protocols for soil analysis. The laboratory should follow recognized methods for measuring each parameter, ensuring consistency and reliability of the results. These methods may include but are not limited to: 3. Bulk Density (g/cm³): Bulk density is typically measured using soil cores or cylinders collected from the field. The soil sample is oven-dried, weighed, and then volume is determined. The bulk density is calculated as the ratio of dry soil mass to its volume. Proper sampling techniques and calibration procedures should be followed to minimize measurement uncertainty. References to recognized standards, protocols, and previous studies validating the chosen methods can strengthen the justification for the data source. Additionally, transparency regarding the measurement procedures, calculation approaches, and associated uncertainties enhances the credibility and reliability of the soil data obtained.
Monitoring frequency	Annually
Purpose of data	☒ Calculation of baseline emissions ☐ Calculation of project emissions ☐ Calculation of leakage
Quality assurance and control	NA
Comments	NA

Data / Parameter	iv) Total Nitrogen (mg/kg)

Unit	mg/kg
Description	iv) Total Nitrogen (mg/kg): Total nitrogen concentration in soil is measured in milligrams per kilogram (mg/kg). Nitrogen is a vital nutrient for plant growth, involved in processes like protein synthesis, chlorophyll production, and enzyme activities. Soil nitrogen levels influence crop yield, soil fertility, and environmental quality.
Origin of data	field collections
Monitored value	NA
Justification of choice of data or description of measurement methods and procedures applied	Given the critical importance of accurate soil data in agricultural and environmental management within the context of AgroEcology_Italy, the choice of data source is paramount. The selected data source should offer reliable information on soil parameters such as Soil Organic Matter (SOM), Phosphorus, Bulk Density, Total Nitrogen, and Organic Carbon. One possible data source could be a soil laboratory that adheres to established standards and protocols for soil analysis. The laboratory should follow recognized methods for measuring each parameter, ensuring consistency and reliability of the results. These methods may include but are not limited to: 4. Total Nitrogen (mg/kg): Total nitrogen content in soil is often determined using Kjeldahl digestion or combustion methods followed by colorimetric analysis. The laboratory should provide details on the digestion and analysis techniques employed, including any corrections or adjustments made to account for various forms of nitrogen. References to recognized standards, protocols, and previous studies validating the chosen methods can strengthen the justification for the data source. Additionally, transparency regarding the measurement procedures, calculation approaches, and associated uncertainties enhances the credibility and reliability of the soil data obtained.
Monitoring frequency	Annually
Purpose of data	☒ Calculation of baseline emissions ☐ Calculation of project emissions ☐ Calculation of leakage
Quality assurance and control	NA
Comments	NA

Data / Parameter	v) Organic Carbon (mg/kg)
Unit	mg/kg

Description	v) Organic Carbon (mg/kg): Organic carbon concentration in soil is measured in milligrams per kilogram (mg/kg). It represents the amount of carbon stored in organic matter within the soil. Organic carbon is a key component of soil organic matter and influences soil structure, water retention, nutrient availability, and microbial activity. Monitoring organic carbon levels is essential for assessing soil quality and ecosystem functioning.
Origin of data	field collections
Monitored value	NA
Justification of choice of data or description of measurement methods and procedures applied	Given the critical importance of accurate soil data in agricultural and environmental management within the context of AgroEcology_Italy, the choice of data source is paramount. The selected data source should offer reliable information on soil parameters such as Soil Organic Matter (SOM), Phosphorus, Bulk Density, Total Nitrogen, and Organic Carbon. One possible data source could be a soil laboratory that adheres to established standards and protocols for soil analysis. The laboratory should follow recognized methods for measuring each parameter, ensuring consistency and reliability of the results. These methods may include but are not limited to: 5. Organic Carbon (mg/kg): Organic carbon content in soil can be measured using methods such as the Walkley-Black or loss on ignition (LOI) method. The laboratory should specify the method used, including details on sample preparation, heating temperatures, and calculation procedures. Uncertainty estimates should be provided for the reported values. References to recognized standards, protocols, and previous studies validating the chosen methods can strengthen the justification for the data source. Additionally, transparency regarding the measurement procedures, calculation approaches, and associated uncertainties enhances the credibility and reliability of the soil data obtained.
Monitoring frequency	Annually
Purpose of data	☒ Calculation of baseline emissions ☐ Calculation of project emissions ☐ Calculation of leakage
Quality assurance and control	NA
Comments	NA

6. Quantification of GHG emission mitigations

The RothC model endeavor adheres to Approach 01 of VM0042 and centers on the advantages of sustainable farming in terms of carbon sequestration. In addition to this analysis, the SoilR package provides an extensive framework for simulating the dynamics of soil carbon across a range of management scenarios.

The Roth C model is well applied in the SOC assessment, especially in Italy. The peer-reviewed studies using the Roth C Model for soil carbon assessment in Italy are mentioned below.

1. Mondini, Claudio, et al. "Soil C storage potential of exogenous organic matter at regional level (Italy) under climate change simulated by RothC model modified for amended soils." Frontiers in Environmental Science 6 (2018): 144. (https://doi.org/10.3389/fenvs.2018.00144)

2. Francaviglia, Rosa, et al. "Changes in soil organic carbon and climate change–Application of the RothC model in agro-silvo-pastoral Mediterranean systems." Agricultural Systems 112 (2012): 48-54. (https://doi.org/10.1016/j.agsy.2012.07.001)

3. Fantin, Valentina, et al. "The RothC Model to Complement Life Cycle Analyses: A Case Study of an Italian Olive Grove." Sustainability 14.1 (2022): 569. (https://doi.org/10.3390/su14010569)

4. Mondini, C., K. Coleman, and A. P. Whitmore. "Spatially explicit modelling of changes in soil organic C in agricultural soils in Italy, 2001–2100: Potential for compost amendment." Agriculture, ecosystems & environment 153 (2012): 24-32. (https://doi.org/10.1016/j.agee.2012.02.020)

5. Mondini, Claudio, et al. "Modification of the RothC model to simulate soil C mineralization of exogenous organic matter." Biogeosciences 14.13 (2017): 3253-3274. (https://doi.org/10.5194/bg-14-3253-2017)

The RothC model, a cornerstone in simulating soil organic carbon dynamics, demarcates organic carbon into distinct compartments each with unique decay rates. This stratification includes Decomposable Plant Material (DPM), Resistant Plant Material (RPM), Microbial Biomass (BIO), Humified Organic Matter (HUM), and Inert Organic Matter (IOM). The R package SoilR leverages this model to assess the decomposition of soil organic matter influenced by various environmental parameters.

The segmentation of soil organic carbon by the RothC model into different pools is instrumental for understanding the intricacies of soil carbon turnover. These pools, characterized by their decay rates, are influenced by soil attributes such as temperature, moisture, and clay content, providing a nuanced view of soil organic matter dynamics.
The decomposition rate for each carbon pool is governed by:

$$DecompRatei = ki \times Ci \times Effectclay \times Effecttemp \times Effectmoist$$

where $DecompRatei$ delineates the decomposition rate for pool i, ki represents the specific decomposition rate constant, Ci the carbon content, and $Effectclay$, $Effecttemp$, and $Effectmoist$ are the environmental modifiers about clay, temperature, and moisture respectively.

Inter-Pool Carbon Fluxes

The transitions between carbon pools follow these relations:

$$DPMnew = (1 - fDPM) \times Input$$

$$RPMnew = fDPM \times Input$$

$$BIOnew = kDPM \times DPM + kRPM \times RPM$$

$$HUMnew = fHUM \times (kDPM \times DPM + kRPM \times RPM)$$

Here, $Input$ stands for the influx of fresh organic carbon, while $fDPM$ and $fHUM$ represent the portions allotted to decomposable material and humified substances, respectively.

Processes of Humification and Inertization

The transformation into humified and inert materials is described by:

HUMincrease = fHUM×BIOnew

$$IOMincrease = fIOM \times HUM$$

with $fIOM$ symbolizing the proportion of humified matter transitioning into inert status.

This approach not only leverages peer-reviewed studies and official data repositories but also engages in original data collection and analysis, providing a robust foundation for assessing the environmental benefits of the AgroEcology_Italy project's regenerative agriculture practices.
Three R scripts were designed for the AgroEcology_Italy project that serve to streamline the process of analyzing soil organic carbon (SOC) dynamics using the RothC model, reflecting a meticulous approach to data handling and simulation that aligns with the project's sustainable agricultural goals.

1. Data Retrieval and Organization: The first script automates the collection of climatic data from MODIS images, covering essential variables such as temperature, precipitation, and evapotranspiration. It involves a process of downloading, organizing, and structuring data into a usable format for modeling, ensuring that the time series are comprehensive and accurately represent the climatic conditions across the project's sites.

2. Data Filtering and Borrowing: This phase deals with refining the dataset to ensure relevance and completeness. It includes filtering the data to include only those properties under the project's purview and employing borrowing techniques for sites with missing data. Such steps are crucial for maintaining the integrity and continuity of the time series, enabling more accurate modeling outcomes.

3. Adjustment for Unavailable Data: Recognizing the limitations in data availability, particularly for recent years, the script incorporates methods to extrapolate or replicate data to fill gaps. This ensures that the model has a complete dataset to work with, minimizing potential inaccuracies in the simulation results due to missing data points.

4. Model Simulation: The second script embodies the core of the SOC dynamics analysis, leveraging the RothC model. It intricately defines the model inputs, including decomposition rates, initial carbon stock levels, and agricultural practice-related changes in carbon inputs. This script represents the project's analytical backbone, processing environmental and management data to simulate how SOC levels might evolve over time under various scenarios.

5. Export and Analysis: The final script transitions from simulation to application, focusing on organizing the RothC model outputs actionable insights. It facilitates data sharing among the project team, generates graphical representations for easy interpretation of the results, and performs statistical analyses to compare SOC levels before and after the implementation of regenerative practices. Moreover, it calculates potential carbon credits, offering a quantitative basis for evaluating the project's impact on carbon sequestration and its financial implications. The results of the RothC model can be seen in the Appendix 12 model outputs.

We also conducted for model calibration and comparison purposes field sampling was to evaluate the impact of agroecology practices ("in") versus conventional farming practices ("out") on soil properties, utilizing the Global Soil Organic Carbon (SOC) map for Italy as a baseline for comparison. This assessment aims to identify how these practices influence soil health indicators, including bulk density, total nitrogen, organic carbon content, soil organic matter (SOM), phosphorus content, and overall carbon sequestration.

Sites were selected based on their agricultural practices, distinguishing between those implementing agroecology practices ("in") and those not ("out"). Each site's geographic coordinates were recorded to correlate soil data with the Global SOC map for Italy, ensuring accurate baseline comparisons.
Soil samples were collected from each site at three different depths (0.1m, 0.2m, and 0.3m) to assess various soil properties. The properties measured included bulk density, total nitrogen (mg/kg), organic carbon (mg/kg), SOM (%), phosphorus content (ppm), and sand fraction (%). In addition, total carbon and overall carbon sequestration (tCha-1 and tCO2ha-1 averages) were calculated.

All soil samples were analyzed in an independent laboratory to ensure unbiased and accurate results.
The Global Soil Organic Carbon Map for Italy served as the baseline for this study. Soil organic carbon data from the map was extracted for the geographic coordinates of each site to compare the SOC values from agroecology and conventional farming sites with national averages. This comparison aimed to assess the effectiveness of agroecology practices in enhancing soil carbon levels relative to the baseline SOC values for Italy.

Bulk Density
Bulk density measurements across the sites ranged from 1.19 g/cm^3 to 1.8 g/cm^3 at a depth of 0.1m. The variation in bulk density suggests differences in soil compaction and porosity across the sites, which can influence water retention and root penetration. Notably, site 100000287, with tillage practices, showed higher bulk densities, indicating potential soil compaction.

Total Nitrogen
Total nitrogen levels varied significantly, with higher concentrations observed at sites practicing agroecology ("in"). For example, sites 100000219 and 100000211b showed nitrogen levels of 5 mg/kg at 0.1m depth, indicative of richer soil nutrient content, potentially due to organic farming practices that enhance nitrogen fixation and reduce nutrient leaching.

Organic Carbon and SOM
Organic carbon content and SOM percentages highlight the organic matter content of the soils, with higher values typically indicating healthier soil with better structure and moisture retention. Sites with "in" designation, such as 100000287c and 100000211b, showed notably higher organic carbon levels and SOM percentages, suggesting that agroecology practices may contribute to increased soil organic matter and carbon sequestration.

Phosphorus Content
Phosphorus content, essential for plant growth, showed variability across sites, with some sites exhibiting higher phosphorus availability at shallower depths. This variability may reflect the influence of agroecological practices, such as crop rotation and organic amendments, on enhancing phosphorus availability.

Sand Fraction and Carbon Sequestration
The sand fraction and carbon sequestration data (tCha-1 and tCO2ha-1 averages) offer insights into the soil texture and its potential for carbon storage. Sites labeled "in" generally showed a trend toward higher carbon sequestration, aligning with the principles of agroecology that promote practices beneficial for long-term carbon storage in soils.

Application of Agroecology Practices
The dataset indicates a clear distinction between sites applying agroecology practices ("in") and those not ("out"). Sites practicing agroecology generally exhibited more favorable soil properties, including lower bulk density,

higher total nitrogen, organic carbon, and SOM percentages, and greater carbon sequestration. This suggests that agroecology practices have a positive impact on soil health and fertility.

In conclusion, the analyzed data reveals significant variations in soil properties across different agricultural sites in Italy, with those employing agroecology practices showing enhanced soil health indicators. These findings underscore the importance of sustainable farming practices in improving soil quality and supporting productive and sustainable agriculture.

Model calibration

The RothC model was calibrated using the SOC values measured from soil samples obtained at 10 sampling sites as provided in Appendix 5 (those sites that start with 10). The correspondent environmental covariates (clay content, temperature, and moisture) for each site, obtained as described above, were included in the calibration procedure, as well as the site-specific carbon inputs based on each agricultural practice conducted at each farm (Appendix 1).

RothC parameters were estimated using the Generalized Likelihood Uncertainty Estimation (GLUE) method, which searches within a Latin Hypercube space for the combination of parameters that maximizes the resemblance between estimated SOC and observed SOC values for each site.

This procedure falls within the requirements stated in VM0042 and VMD0045 in the sense that it takes empirical values and works by tuning parameters to reduce prediction bias, and was already reported in the literature as robust for parameter estimation in RothC models:

- Cagnarini, Claudia, et al. "Multi-objective calibration of RothC using measured carbon stocks and auxiliary data of a long-term experiment in Switzerland". European Journal of Soil Science (2019), 70(4), 819-832.

The calibration procedure aimed at estimating seven parameters of the RothC model: the decomposition rates (k) for all five compartments (DPM, RPM, BIO, HUM, and IOM), the DPM/RPM ratio (DR), and the evaporation coefficient. Estimating all parameters simultaneously is possible under the GLUE method and increases model accuracy. We used parameter intervals based on the default values of SoilR package and the expectations in the aforementioned paper. We generated 100,000 parameter sets and simulated the carbon dynamics of each site from the baseline SOC (average between 1990 and 2013) and until the month when soil samples were taken (December 2023) using each parameter set, independently.

To approach the recommendations in VM0042, the accuracy of predictions based on each parameter set was assessed using the Root Mean Squared Error (RMSE). From the final distribution of RMSE for all parameter sets, we selected the 2,5%-quantile representing the 2,500 parameter sets with highest accuracy and built the posterior distributions for each parameter (Figure 1). We then used the mean of each posterior distributions to calculate the parameter estimates provided in Table 2.

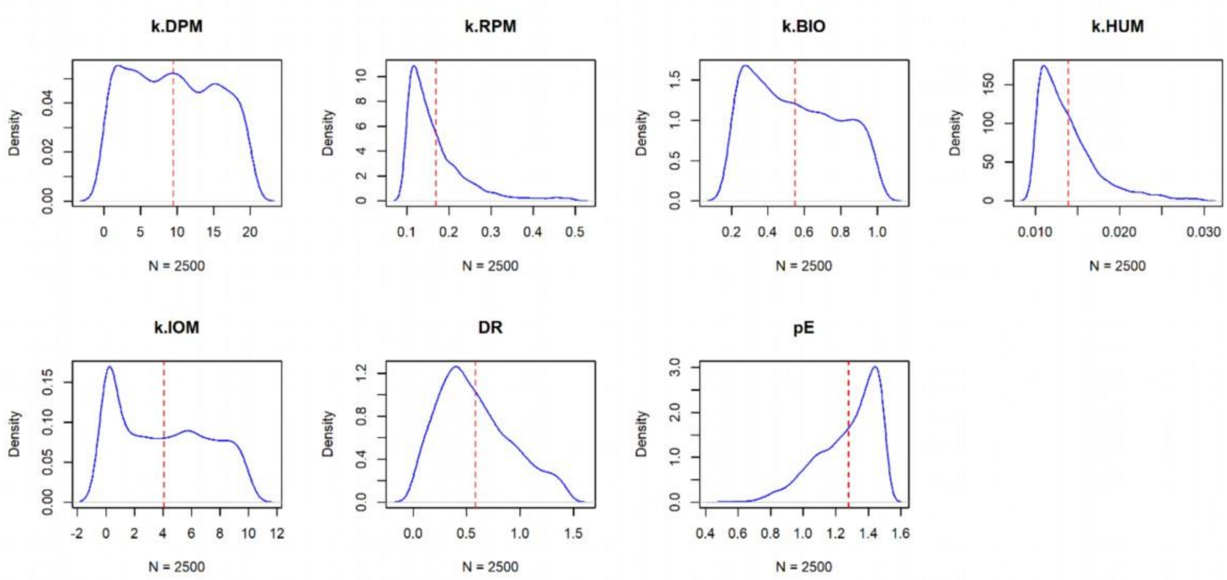

Figure 12 – Marginal posterior distributions of the seven RothC model parameters estimated using Generalized Likelihood Uncertainty Estimation (GLUE). These posterior distributions considered the 2,500 parameter sets with the lowest Root Mean Squared Error (RMSE). Estimated parameters: decomposition rates (k) for all five compartments (DPM, RPM, BIO, HUM, and IOM), the DPM/RPM ratio (DR), and the evaporation coefficient (pE).

Table 2 – Estimates and standard errors (S.E.) of the mean for the seven parameters estimated under the RothC model calibration procedure. Estimated parameters: decomposition rates (k) for all five compartments (DPM, RPM, BIO, HUM, and IOM), the DPM/RPM ratio (DR), and the evaporation coefficient (pE). Standard errors were obtained by dividing the standard deviation of posterior distributions by the number of parameters sets considered.

Parameter	k.DPM	k.RPM	k.BIO	k.HUM	k.IOM	DR	pE
Estimate	9.495	0.169	0.548	0.014	4.060	0.581	1.278
SE	0.117	0.001	0.005	0.00007	0.064	0.007	0.004

After calibration and parameter estimation, we used the estimates from Table 1 to simulate the SOC dynamics for each of the 10 sites where soil samples were collected. This was done to assess whether the predicted values matched the observed SOC values. Results showed that the modeled values were able to match the empirical SOC values at a 98% precision rate based on a simple linear model between observed and predicted SOC (Figure 2). This result implies that the calibration procedure yielded parameter estimates that were able to reproduce the empirical SOC values for all 10 sites at a high accuracy.

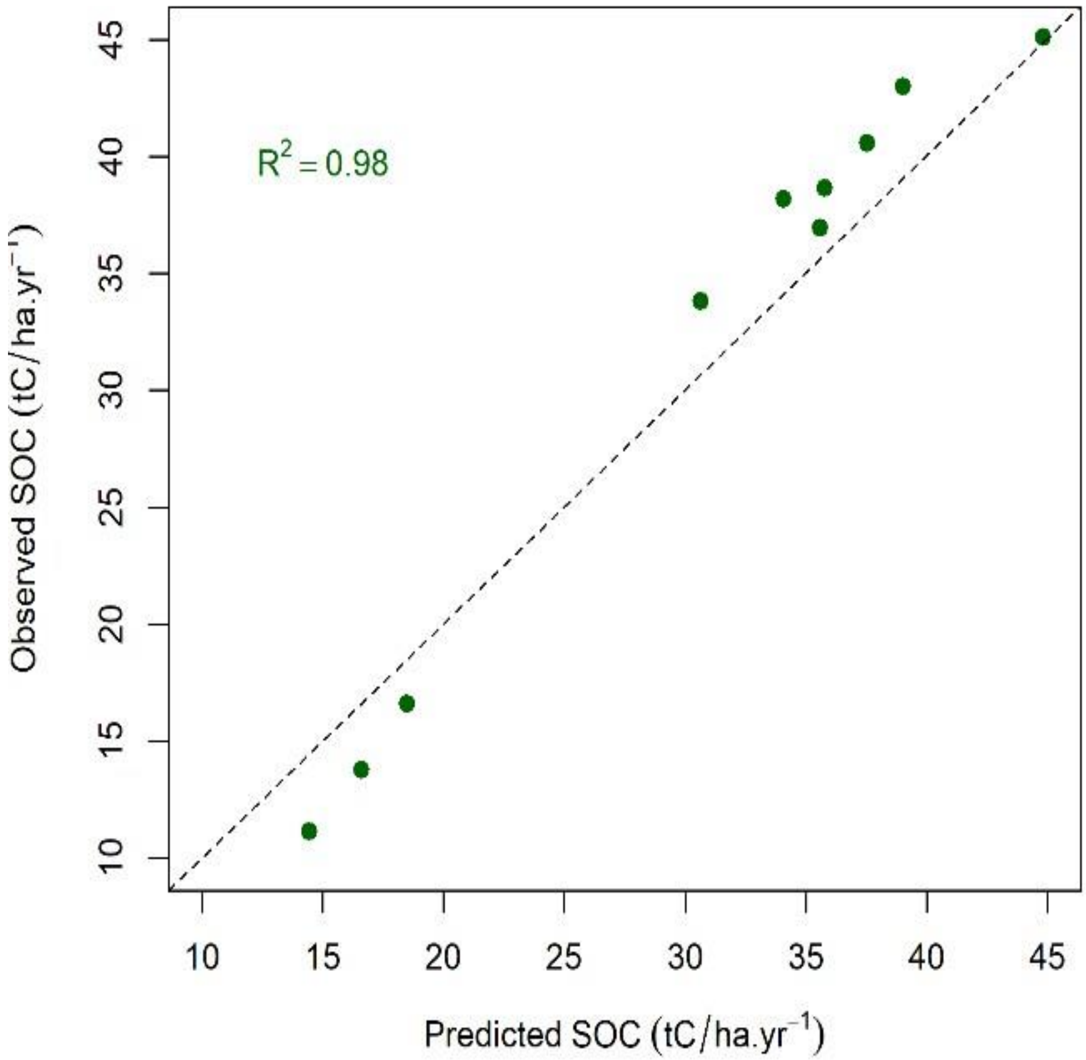

Figure 13 - Observed SOC values (obtained from soil samples) versus predicted SOC (RothC model run based on parameter estimates obtained as the mean of marginal posterior distributions; Table 1). The R^2 value portrays the coefficient of determination of a linear model fitted to this observed-predicted relationship. The diagonal dashed line represents the expected 1:1 relationship.

6.1 Baseline emissions

The baseline utilized in this study was derived from the Global Soil Organic Carbon map for Italy, which estimates the soil organic carbon stock (CS) within the 0-30 cm depth range. This estimation was based on data collected between 1990 and 2013, encompassing a considerable dataset of 6748 sampled points. The corrected soil organic carbon (SOC) values, along with estimated bulk density, were employed to generate the map. The mapping process employed sophisticated interpolation techniques such as neural networks and Generalized Linear Models (GLM). To ensure the accuracy of the mapping outcomes, validation was conducted using statistical metrics like Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE). For inquiries regarding the data, interested parties may contact the Research Centre for Agriculture and Environment (CREA).
The methodology for modeling the data between 2013 and 2021 relied on the RothC model. This decision was based on the temporal coverage of the available data, which spanned from 1990 to 2013, aligning with the point sample collection period. Leveraging the RothC model, we simulated the data for the interval between 2013 and 2021, integrating inputs associated with the land use history of the initial properties. Fantappie et al. (2018) found that the starting point for the soil organic carbon (SOC) stock was found by taking the average of the SOC values that were recorded between 1990 and 2013. Additionally, data on clay (%) and soil depth (cm) were sourced from the 500-meter grid of Derived Soil Profiles (DSP) for Italy - SuoliCella500.
Subsequently, to capture carbon dynamics from 2014 to 2020, we obtained environmental variables using the Google Earth Engine platform. These variables included CHIRPS Rainfall, MODIS Temperature, and evapotranspiration (ASCE Penman-Montieth) for the specified time frame and the subsequent period from 2021 to 2023. Carbon inputs for the initial period were maintained constant, reflecting the expected input for olive tree crops based on surveys and agricultural practice inputs, equivalent to 0.06 per month. Following this, carbon inputs for each property were adjusted based on the agricultural practices implemented, allowing for a more nuanced representation of carbon dynamics over time.

6.2 Project emissions

There are no emissions activities, and emissions are considered to be nil. As a result, the overall emissions for the project is nil.

6.3 Leakage

There is no displacement of agricultural activities, and leakage is considered to be nil. As a result, the overall leakage for the project is nil.

6.4 Risk assessment for permanence

The "AgroEcology_Italy" project utilized the AFOLU Non-Permanence Risk Tool Version 4.0 developed by Verra to assess internal, external, and natural risks along with mitigation measures. This assessment involved a comprehensive evaluation of various risk factors to ensure the project's long-term sustainability and carbon sequestration potential.

Internal Risks:
- The project ensured the use of indigenous species suitable for the Italian and Mediterranean regions, minimizing the risk of introducing new species.
- Detailed organograms and resource personnel lists were provided, demonstrating the project team's competency and readiness.
- Funding for project registration and carbon credit issuance was secured, along with documented cash flow for the project's initial phase.
- Contractual agreements with participating growers/farmers were established for the entire 45-year crediting period, ensuring commitment and continuity.

External Risks:

- Project ownership and land ownership were delineated, mitigating potential disputes or conflicts.
- Governance scores obtained from the World Bank portal indicated a stable environment for project implementation.

Natural Risks:
- Geological risks, extreme weather events, and pest/disease outbreaks were considered, with appropriate mitigation strategies such as integrated pest management and reduced pesticide application.
- Fire risk was minimized through the prohibition of biomass burning.

The overall risk assessment yielded a rating of 11 points, well below the threshold for unacceptable risk.
Mitigation and Buffer Determination:
To further mitigate risks and ensure long-term project sustainability, the project implemented a unique credit distribution strategy termed "Participation Credits." This strategy incentivizes long-term engagement, enhances risk mitigation, and aligns stakeholders' interests with the project's goals. By setting aside additional credits and distributing them over specific periods, the project motivates farmers, offers financial security, and preserves credit value. This comprehensive strategy not only addresses potential risks but also positions stakeholders to benefit from the growth of the carbon credit market, ensuring the project's success and environmental impact over time. Additionally, adherence to buffer adjustment account deposits further underscores the project's commitment to sustainability and integrity within the carbon market.

6.5 Net GHG emission mitigations

All equations were provided in item 6. 6. Quantification of GHG emission mitigations

Year	Estimated baseline emissions or removal	Number of Hectares	Estimated ER total	GHG Increase	Leakage	Buffer (AFOLU + CDR)	Estimated Net Carbon Removal (tCO2e)
			Agroecology Project			10%	
2022	0	1,114.06	1,899.03	-	-	190	**1,709**
2023	0	1,474.89	6,145.53	-	-	615	**5,531**
Total Buffer						**804.45**	**8,045**
Total Estimated Net Carbon Removal (tCO2e)							**7,240**
Total Crediting years							**2**

6.6 Comparison to estimated GHG emission mitigations.

Year	Ex-ante estimation (tCO_2e)	Monitored impacts (tCO_2e)	%	Explanation
1 January 2022 to 31 December 2022	1,899.03	1,899.03	0	There were no discrepancies between the estimated greenhouse gas (GHG) emission mitigations (ex-ante) and the monitored GHG emission mitigations (ex-post) for the monitoring period because the monitoring and estimation process was conducted simultaneously. That is, the estimates and the monitored data are outcomes of applying the RothC model, which has been previously calibrated with land use data and soil samples analyzed in the laboratory.
1 January 2023 to 31 December 2024	6,145.53	6,145.53	0	
Total	8,044,56	8,044,56	0	

7. Management of data quality

Authorization, Approval, and Documentation of Data Changes:
The entire Data Quality Management process in this report followed the Data Quality ManagementData Quality Management Document (DQMD) for the "AgroEcology_Italy" Appendix 13.

Changes to recorded data within the "AgroEcology_Italy" project follow a strict authorization, approval, and documentation process. Initially, any request for a data change must be formally submitted, detailing the rationale, the specific data affected, and the expected impact. Authorized personnel evaluate this request to determine whether the change is necessary and what effects it might have. Upon approval, the change is documented, specifying the nature of the alteration, the individual responsible, and the date of modification. This documentation is stored in a secure, centralized system, accessible only to authorized staff, ensuring traceability and accountability.

Controls for Internal Data Checks and Corrective Actions:

The project employs rigorous internal checks at various stages—input, transformation, and output—to maintain data integrity. While version control governs transformation processes to ensure consistency, automated validation rules during data entry minimize errors. Output data undergoes thorough reviews and quality checks against predefined standards. If discrepancies or errors are detected at any stage, a structured corrective action procedure is initiated, which includes an in-depth investigation, rectification measures, documentation, and a review to prevent future occurrences. These protocols align with ISO standards, ensuring methodical data handling and quality assurance.

Data Location, Retention, and Transfer Procedures:

All project data is stored in secure, centralized databases that comply with ISO/IEC 27001 and 27002 standards, guaranteeing data integrity, security, and accessibility. Data retention policies are clearly defined, balancing operational requirements with legal and ethical obligations. For data transfer between systems or documentation, standardized procedures ensure the secure and accurate migration of data, with comprehensive documentation of the process, participants, and data provenance. This ensures seamless integration and consistency across different platforms and formats.

Quality Management Procedures Compliance and Uncertainty Assessment Integration:

The project's data quality management follows the procedures established in the design description, adhering to international ISO standards such as ISO 9001 for quality management and ISO/IEC 15939 for software measurement. These procedures have been meticulously applied to manage data relevant to both the project's operations and the baseline scenario. Training programs, regular audits, and continuous improvement processes have been implemented to ensure consistent adherence to these standards.

Additionally, the project incorporates the results of uncertainty assessments into its operations. This involves adjusting data collection and analysis methods based on identified uncertainties to enhance the accuracy and reliability of project outcomes. By systematically addressing uncertainty, the project not only improves data quality but also ensures that decisions are informed and reflective of real-world conditions.

8. References

1. Farina, R.; Testani, E.; Campanelli, G. Leteo, F. et al."Potential carbon sequestration in a Mediterranean organic vegetable cropping system. A model approach for evaluating the effects of compost and Agro-ecological Service Crops (ASCs)". Agricultural Systems 162 (2018): 239-248.

2. Gattinger, A.; Muller, A.; Haeni, M.; Skinner, C. et al. "Enhanced top soil carbon stocks under organic farming". Proceedings of the National Academy of Sciences 109.44 (2012): 18226-18231.
3. Lazzerini, G.; Migliorini, P.; Mochini, V.; Pacini, C.; Merante, P.; Vazzana, C. "A simplified method for the assessment of carbon balance in agriculture: an application in organic and conventional micro-agroecosystems in a long-term experiment in Tuscany, Italy." Italian Journal of Agronomy 9.2 (2014): 55-62.
4. Namirembe, S.; Piikki, K.; Sommer, R.; Soderstrom, M.; Tessema, B.; Nyawira, S.: "Soil organic carbon in agricultural systems of six countries in East Africa – a literature review of status and carbon sequestration potential". South African Journal of Plant and Soil (2020): 1-16.
5. Petersson, T.; Perugini L. C., Chiriaco, M. V.: "D2 report: quality and quantity of data available for each identified crop/Livestock carbon farming practice. Action A.2. 2017.
6. Poeplau, C.; Don, A. "Carbon sequestration in agricultural soils via cultivation of cover crops–A meta-analysis." Agriculture, Ecosystems & Environment 200 (2015): 33-41.
7. Powlson, D. S.; Bhogal, A.; Chambers, B. J.; Coleman, k.; Macdonald, A. J.; Gouding, K. W. T.; Whitmore, A. P.: "The potential to increase soil carbon stocks through reduced tillage or organic material additions in England and Wales: A case study". Agriculture, Ecosystems and Environment 146 (2012): 23-33.
8. Sacco, D.; Moretti, B.; Stefano, M.; Grignami, C.: "Six-year transition from conventional to organic farming: effects on crop production and soil quality". Europ. J. Agronomy 69 (2015): 10-20.
9. Álvaro-Fuentes, J., et al. "Soil carbon dioxide fluxes following tillage in semiarid Mediterranean agroecosystems." Soil and Tillage Research 96.1-2 (2007): 331-341.
10. Álvaro-Fuentes, J., et al. "Tillage effects on soil organic carbon fractions in Mediterranean dryland agroecosystems." Soil Science Society of America Journal 72.2 (2008): 541-547.
11. Álvaro-Fuentes, J., et al. "Soil organic carbon storage in a no-tillage chronosequence under Mediterranean conditions." Plant and Soil 376 (2014): 31-41.
12. Baiamonte, G.; Gristina, L.; Orlando, S., et al. "No-Till Soil Organic Carbon Sequestration Patterns as Affected by Climate and Soil Erosion in the Arable Land of Mediterranean Europe". Remote Sens. (2022): 14, 4064.
13. Cillis, D.; Maestrini, B.; Pezzuolo, A., et al. "Modeling soil organic carbon and carbon dioxide emissions in different tillage systems supported by precision agriculture technologies under current climatic conditions." Soil and Tillage Research 183 (2018): 51-59.
14. Fiorini, A.; Bosellia, R.; Maris, S. C. et al. "Soil type and cropping system as drivers of soil quality indicators response to no-till: A 7-year field study." Applied Soil Ecology 155 (2020): 103646.
15. Mazzoncini, M.; Sapkota, T. B.; Barberi, P., et al. "Long-term effect of tillage, nitrogen fertilization and cover crops on soil organic carbon and total nitrogen content". Soil & Tillage Research 114 (2011): 165–174.
16. Troccoli, A.; Russo, M.; Farina, R. "Is it Sustainable to Cultivate a Monoculture of Durum Wheat with Prolonged No-Tillage Management?". Annals of Agricultural & Crop Sciences (2022): 1-10.
17. Lal, R. "Soil carbon sequestration and aggregation by cover cropping." Journal of Soil and Water Conservation 70.6 (2015): 329-339.
18. Sartori, F.; Lal, R.; Ebinger, M. H.; Parrish, D. J. "Potential soil carbon sequestration and CO2 offset by dedicated energy crops in the USA." Critical Reviews in Plant Sciences 25.5 (2006): 441-472.
19. Zhang, K.; Dang, H.; Tan, S., et al. "Change in soil organic carbon following the 'Grain-for-Green'programme in China." Land degradation & development 21.1 (2010): 13-23.
20. FAO, 2021. The state of the world's land and water resources for food and agriculture – Systems at breaking point. Synthesis report 2021. Rome. https://doi.org/10.4060/cb7654en.
21. IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2391 pp. doi:10.1017/9781009157896.

22. Franzluebbers, A. J. "Soil organic carbon sequestration and agricultural greenhouse gas emissions in the southeastern USA." Soil and Tillage research 83.1 (2005): 120-147.
23. Jian, J.; Du, X.; Reiter, M. S.; Stewart, R. D. "A meta-analysis of global cropland soil carbon changes due to cover cropping." Soil Biology and Biochemistry 143 (2020): 107735.
24. Locatelli, J.; Bratti, F.; Ribeiro, R. et al. Soil carbon sequestration and stocks: short-term impact of maize succession to cover crops in Southern Brazil Inceptisol. Spanish Journal of Agricultural Research 18 (2020): 1-7.
25. Francaviglia, R.; Di bene, C.; Farina, R.; Salvati, L. "Soil organic carbon sequestration and tillage systems in the Mediterranean Basin: a data mining approach." Nutrient Cycling in Agroecosystems 107 (2017): 125-137.
26. Blonska, E.; Kacprzyk M.; Spolnik, A. "Effect of deadwood of different tree species in various stages of decomposition on biochemical soil properties and carbon storage". Ecol Res 32 (2017): 193–203.
27. Galan-Martin, A.; Contreras, M. M.; Romero, I., et al. "The potential role of olive groves to deliver carbon dioxide removal in a carbon-neutral Europe: Opportunities and challenges". Renewable and Sustainable Energy Reviews 165 (2022): 112609.
28. Gomez-Munoz, B.; Valero-Valenzuela, J. D.; Hinojosa, M. B.; Garcia-Ruiz, R. "Management of tree pruning residues to improve soil organic carbon in olive groves". European Journal of Soil Biology 74 (2016): 104e113.
29. Knoblauch, C.; Renuka-Priyadarshani, S. H.; Haefele, S. M., et al. "Impact of biochar on nutrient supply, crop yield and microbial respiration on sandy soils of northern Germany". Eur J Soil Sci. (2021): 1–17.
30. Michalopoulos, G.; Kasapi, K. A.; Koubouris, G., et al. "Adaptation of Mediterranean Olive Groves to Climate Change through Sustainable Cultivation Practices". Climate (2020): 1-11.
31. Smith, P.; Davis, S. J.; Creutzig, F., et al. "Biophysical and economic limits to negative CO2 emissions". Nature Climate Change (2015):10.1038/NCLIMATE2870.
32. Freibauer, A.; Rounsevell, M. D. A.; Smith, P.; Verhagen, J. "Carbon sequestration in the agricultural soils of Europe". Geoderma 122 (2004): 1-23.
33. Musacchi, S.; Iglesias, I.; Neri, D. "Training Systems and Sustainable Orchard Management for European Pear (Pyrus communis L.) in the Mediterranean Area: A Review". Agronomy (2021): 11, 1765.
34. Ronga, M.; Chiriacò, M. V; Pellis, G., et al. "Metodologia per l'attuazione di meccanismi volontari di riduzione e compensazione delle emissioni a livello di distretto zootecnico". Ismea-Mipaaft, 2018.
35. Berge, H. F. M.; Meer, H. G.; Steenhuizen, J. W., et al. "Olivine weathering in soil, and its effects on growth and nutrient uptake in ryegrass (Lolium perenne L.): a pot experiment." (2012): e42098.
36. Dietzen, C.; Harrison, R.; Michelsen-Correa, S. "Effectiveness of enhanced mineral weathering as a carbon sequestration tool and alternative to agricultural lime: an incubation experiment." International Journal of Greenhouse Gas Control 74 (2018): 251-258.
37. Haque, F.; Santos R. M.; Chiang, Y. W. "Optimizing inorganic carbon sequestration and crop yield with wollastonite soil amendment in a microplot study." Frontiers in plant science 11 (2020): 1012.
38. Kelland, E. M.; Wade, P. W.; Lewis, A. L., et al. "Increased yield and CO2 sequestration potential with the C4 cereal Sorghum bicolor cultivated in basaltic rock dust-amended agricultural soil." Global Change Biology 26.6 (2020): 3658-3676.
39. Swoboda, P.; Döring, T. F.; Hamer, M. "Remineralizing soils? The agricultural usage of silicate rock powders: A review." Science of The Total Environment 807 (2022): 150976.
40. Thorben, A.; Hartmann, J.; Struyf, E., et al. "Enhanced Weathering and related element fluxes–a cropland mesocosm approach." Biogeosciences 17.1 (2020): 103-119.
41. Cooper, J.; Baranski, M.; Stewart, G.; et al. "Shallow non-inversion tillage in organic farming maintains crop yields and increases soil C stocks: a meta-analysis". Agron. Sustain. Dev. 36 (2016): 1-22.
42. Krauss, M.; Berner, A.; Perrochet, F.; et al. "Enhanced soil quality with reduced tillage and solid manures in organic farming – a synthesis of 15 years". Scientific reports (2020): 10:4403.
43. Krauss, M.; Wiesmeier, M.; Don, A., et al. "Reduced tillage in organic farming affects soil organic carbon stocks in temperate Europe". Soil & Tillage Research 216 (2022): 105262.
44. Bertora, C.; Zavattaro, L.; Secco, D.; et al. "Soil organic matter dynamics and losses in manured maize-based forage systems." European Journal of Agronomy 30.3 (2009): 177-186.

45. Forte, A.; Fagnano, M.; Fierro, A. "Potential role of compost and green manure amendment to mitigate soil GHGs emissions in Mediterranean drip irrigated maize production systems." Journal of environmental management 192 (2017): 68-78.
46. Tomasoni, C., Tosca, A.; Valagussa, M.; et al. "Effect of integrated forage rotation and manure management systems on soil Nitrogen content." Proceedings of the 16th Nitrogen Workshop: Connecting Different Scales of Nitrogen Use in Agriculture. Facoltà di Agraria, Università di Torino, 2009.
47. Maris, S. C.; Fiorini, A.; Boselli, R., et al. "Cover crops, compost, and conversion to grassland to increase soil C and N stock in intensive agrosystems." Nutrient Cycling in Agroecosystems 119 (2021): 83-101.
48. Morari, F.; Lugato, E.; Berti, A.; Giardini, L. "Long-term effects of recommended management practices on soil carbon changes and sequestration in north-eastern Italy." Soil Use and Management 22.1 (2006): 71-81.
49. Tommaso, C.; Blasi, E.; Guido, P., et al. "Soil organic carbon pool's contribution to climate change mitigation on marginal land of a Mediterranean montane area in Italy." Journal of Environmental Management 218 (2018): 593-601.
50. Chiti, T.; Pellis, G.; Manso,S., et al. "Soil carbon data in the Mediterranean region". Project MediNet (2018): 1-64.
51. Regni, L.; Nasini, L.; Ilarioni, L., et al. "Long term amendment with fresh and composted solid olive mill waste on olive grove affects Carbon sequestration by frunings, fruits, and soil". Soil. Front. Plant Sci. 7 (2017): 2042.
52. Desta, G. A., Melka, Y., Sime, G., Yirga, F., Marie, M., & Haile, M. (2020). Biogas technology in fuelwood saving and carbon emission reduction in southern Ethiopia. Heliyon.
53. Wolske, K. S., Raimi, K., Campbell-Arvai, V., & Hart, P. S. (2019). Public support for carbon dioxide removal strategies: the role of tampering with nature perceptions. Climatic Change, 152, 345-361.
54. Suter, M. K., Miller, K. A., Anggraeni, I., Ebi, K., Game, E., Krenz, J., Masuda, Y., Sheppard, L., Wolff, N., & Spector, J. (2019). Association between work in deforested, compared to forested, areas and human heat strain: an experimental study in a rural tropical environment. Environmental Research Letters, 14.
55. Amaducci, S., Zatta, A., Pelatti, F., & Venturi, G. (2015). Influence of agronomic factors on yield and quality of hemp (Cannabis sativa L.) fiber and implication for an innovative production system. BIO Web of Conferences, 10.1051/bioconf/202410810001.
56. Bouloc, P., Allegret, S., & Arnaud, L. (2022). Sustainability assessment of hemp (Cannabis sativa L.): Ecological, economic, and social indicators. Sustainability, 14(7), 4159.
57. Hartl, J., & Hess, M. (2024). Hemp cultivation and its environmental impact: A comprehensive review. Frontiers in Environmental Science, 8, 1342330.
58. Taylor, P., & Williams, J. (2022). The economic and environmental benefits of hemp-based carbon sequestration. SSRN Electronic Journal.
59. Fantappiè, M.; Calzolari, C.; Ungaro, F., et al. “Elaboration of the Italian portion of the global soil organic carbon map (GSOCMAP). Zenoob 5 (2018): 10.5281/zenodo.7746494.

Appendix I

Section	file name
Appendix 1	AP1 T1 FARMERS
Appendix 2	AP2 SDG impacts during the monitoring period
Appendix 2.1	Farmers' Feedback - Re SDGs
Appendix 2.2	Summary of survey responses on SDGs
Appendix 2.3	Complete Fee Schedule & Earnings for Farmers.pdf
Appendix 3.1	AP3.1 REGULATION (EU) 2018841
Appendix 3.2	AP3.2 REGULATION (EU) 20211119
Appendix 3.3	AP3.3 EU Nature Directives
Appendix 3.4	AP3.4 EU Forest Strategy for 2030
Appendix 3.5	AP3.5 (a) Occupational Health and Safety Act (D.Lgs. 81:2008) – DECRETO LEGISLATIVO 9 aprile 2008, n. 81
Appendix 3.6	AP3.6 (b) Fair Labor Standards Act (D.Lgs. 66:2003) – DECRETO LEGISLATIVO 8 aprile 2003, n. 66
Appendix 3.7	AP3.7 Civil Rights Act of 1964 (Legge n. 903:1977) – LEGGE 9 dicembre 1977 , n. 903
Appendix 3.8	AP3.8 Civil Rights Act of 1964 (Legge n. 903:1977)
Appendix 3.9	AP3.9 (d) Italian Law on Disability Discrimination – DECRETO LEGISLATIVO 9 luglio 2003 , n. 215
Appendix 3.10	AP3.10 (d) Italian Law on Disability Discrimination – DECRETO LEGISLATIVO 9 luglio 2003 , n. 216
Appendix 3.11	AP3.11 (e) Environmental Impact Assessment (D.Lgs. 152:2006) – DECRETO LEGISLATIVO 3 aprile 2006 , n. 152
Appendix 3.12	AP3.12 (f) Water Pollution Control Act (D.Lgs. 152:2006) – DECRETO LEGISLATIVO 3 aprile 2006, n. 152
Appendix 3.13	AP3.13 (g) Land Use Planning Act (D.Lgs. 42:2004) – DECRETO LEGISLATIVO 22 gennaio 2004, n. 42
Appendix 3.14	AP3.14 (h) Food Security Act (D.Lgs. 193:2007) – Decreto Legislativo 6 novembre 2007, n. 193
Appendix 4	AP4 Report of Stakeholder Consultation Events for the Agroecology Project
Appendix 5	AP5 Tabulated result of soil samples taken in the field and measured in the laboratory
Appendix 6	AP6 Temperature TerraClimate Monthly
Appendix 7	AP7 Precipitation TerraClimate Monthly
Appendix 8	AP8 MODIS Evapotranpitation TerraClimate Monthly
Appendix 9	AP9 practices inputs RothC
Appendix 10	AP10 C_baseline Global Soil Organic Carbon map
Appendix 11	AP11 inputs_time_series
Appendix 12	AP12 RothC result outputs
Appendix 13	Data Quality ManagementData Quality Management Document (DQMD) for the “AgroEcology_Italy"
Appendix 14	Project Gantt
Appendix 15	Company registration report
Appendix 16	Ex Ante and Post Credit Generation Estimation tCO2e
Appendix 17	Validation Verifcation
Appendix 18	Complete Fee Schedule & Earnings for Farmers